DECEMBER 1956

Product Engineering

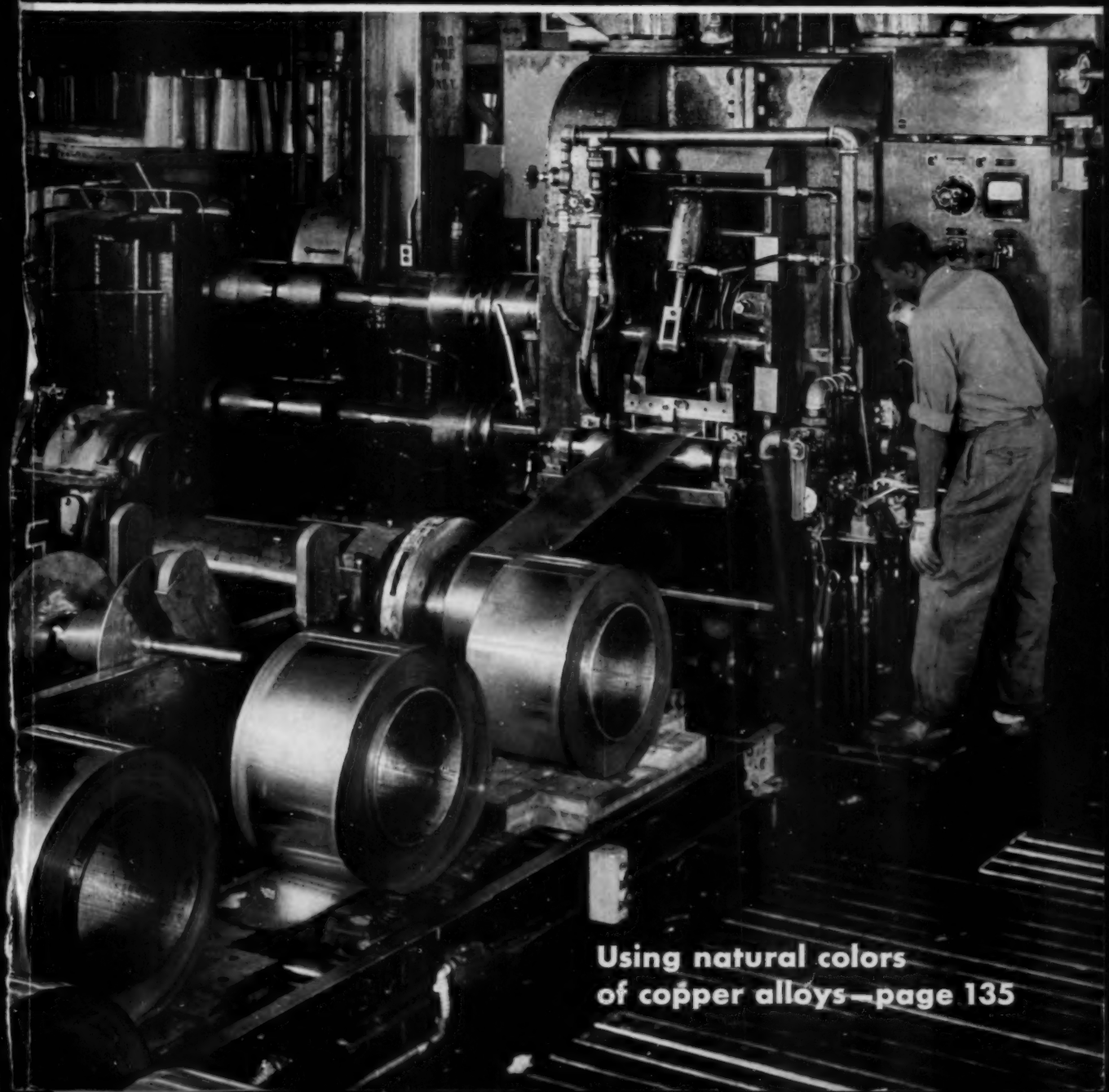
THE McGRAW-HILL MAGAZINE OF DESIGN ENGINEERING
FIVE DOLLARS A YEAR

Colored finishes for
Copper and Brass

Speed-Torque Analysis

Relief Valves

Nickel-Free Stainless

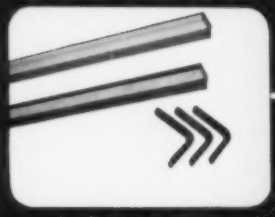


Using natural colors
of copper alloys—page 135

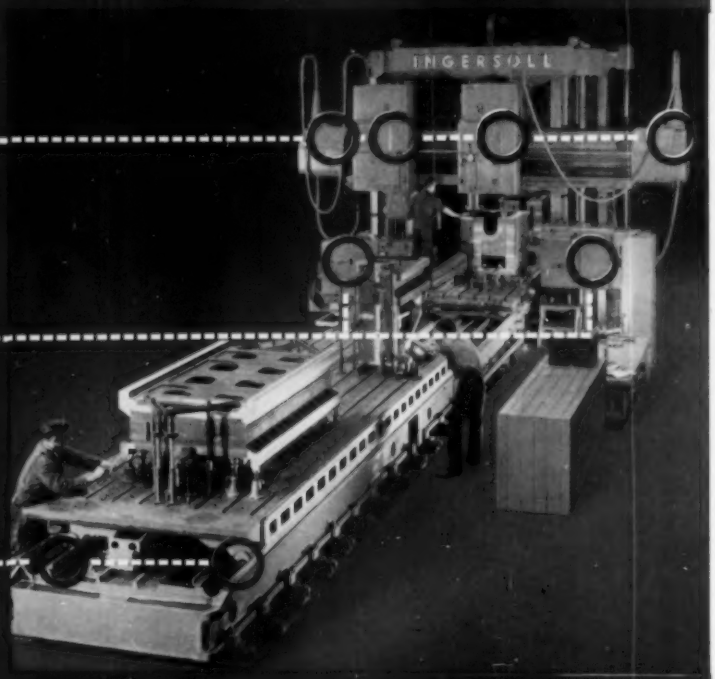
FOR PERFORMANCE PROTECTION

C/R SHAFT SEALS

C/R END FACE SEALS



C/R SIRVENE WAY WIPERS



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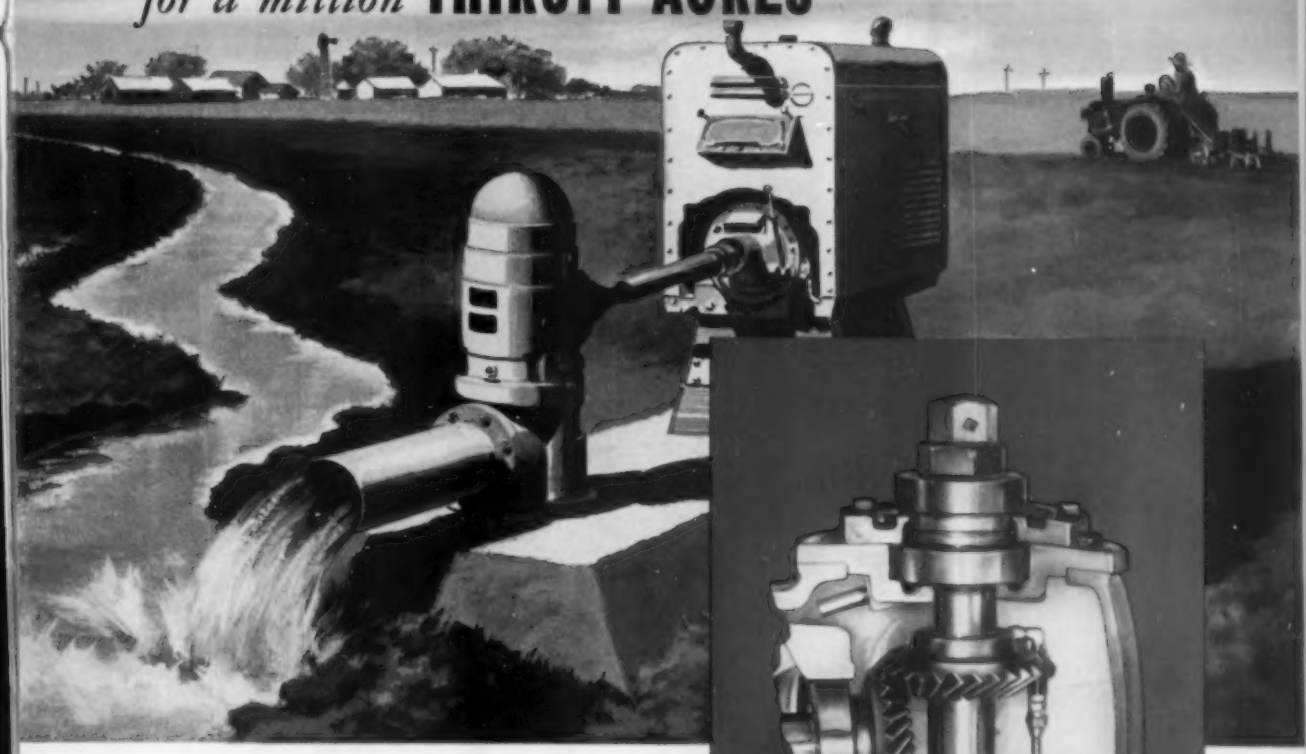

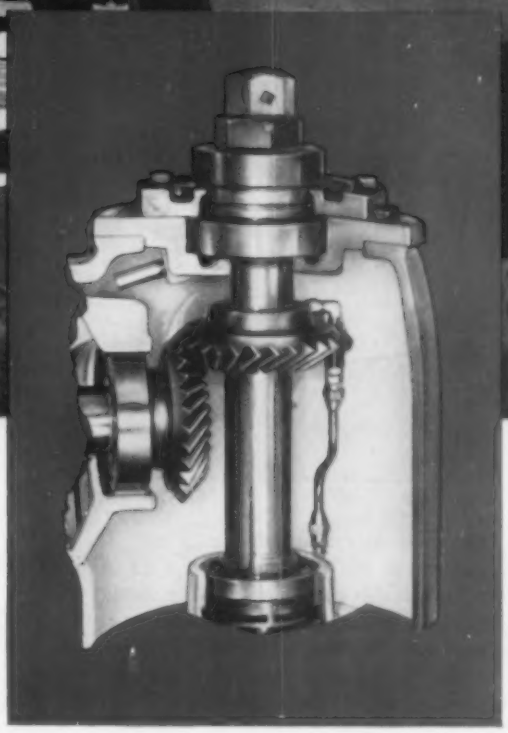

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Product Engineering

DECEMBER 1956 Vol. 27 No. 13 The McGraw-Hill Magazine of Design Engineering

Colored Finishes for Copper ..... A. I. Heim 135
Natural finishes on copper and copper alloys, shown in actual color, as obtained through combined chemical conversion and mechanical treatment of surface; coloring solutions and treatments; bulk finishing and bright dipping; fabricating methods.

Ceramic Magnets ..... Richard A. Scholten 143
Comparison of barium ferrite magnets with Alnicos; how to apply their coercive force and potential energy; holding, torque, and generator applications.

Research in the Library ..... Allen Kent 149
Survey of libraries in 100 metallurgical companies to determine awareness of the contribution of the library to research effort.

A New Nickel-Free Stainless ..... Whittenberger, Witchey and Rudolphy 151
Mechanical properties and corrosion resistance of austenitic stainless alloy containing manganese and nitrogen in place of nickel.

Design Features in New Products 154
Compressor speed increase lessens size and weight; nodal point engine mounts; vacuum-operated air flow dampers; air-cushioned rear spring; less parts, weight in wheel suspension; reinforced plastic truck grill; bellows redesigned for welding; reshaped calculator housing; restyled mower; unitized system controls lathe; toggles change linear to rotary motion; lapped joint helps with tolerances; hidden rivet joins tubular parts.

Measurement and Control of Chatter in Gear Drives ... C. E. Rose and G. F. Hadley 168
Chatter analysis by instrument; equations for computing speed variations and eccentricity; recommendations for gear reducers and drive motors.

Silicone Shoes for Brakes ..... A. P. Bettick 172
How brake performance is increased by combining sintered linings and molded silicone shoes.

Hydraulic Control Valves: I—Relief Valves ..... John J. Pippinger 174
First of a series covering identification, function, construction, and installation, for three major valve types: pressure, flow and directional control.

Electrical Terminal Connections ..... Frederico Strasser 182
Twenty-nine methods of fastening wire to terminals.

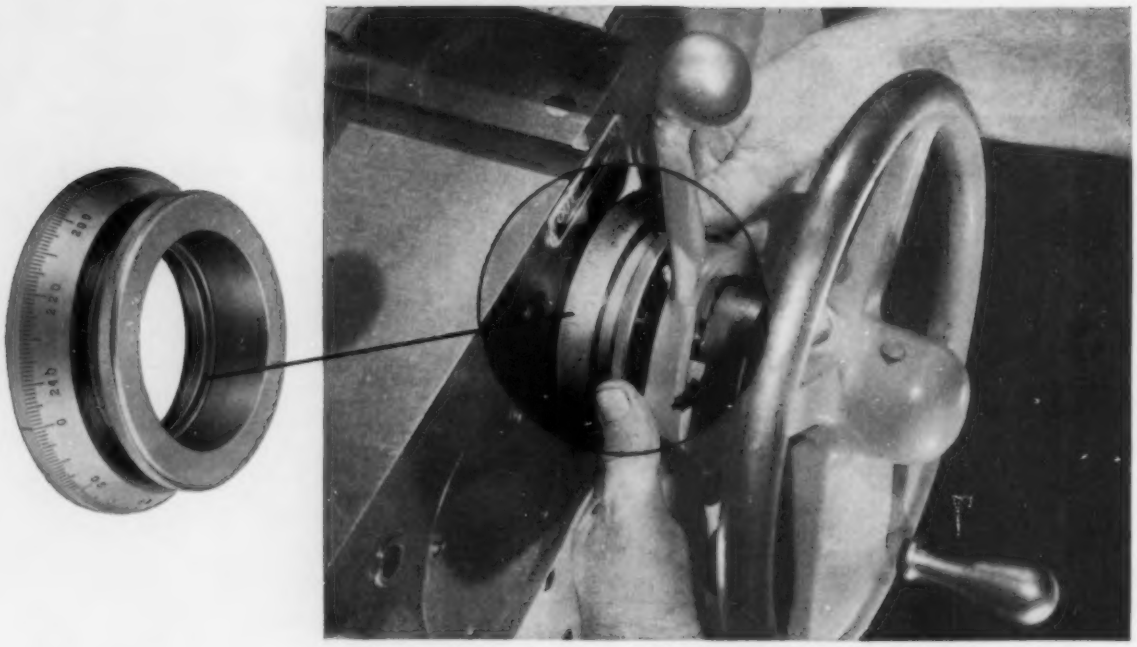
Speed-Torque Analysis for Rotating Mechanical Systems ..... V. H. Seliger 184
Method for deriving and solving equations for speed and torque in an ideal system.

Corrosion of Dissimilar Metals ..... Ulick R. Evans and Vera E. Rand 187
Relative corrosion of dissimilar metals in contact; effect of electrolyte, metallic coatings and other factors; methods of preventing corrosion.

Selection Guide for Steels ..... Dominic Mascio 211
Data on strength, ductility, applications, relative costs, machinability.

INDEX TO VOLUME 27 FOLLOWS PAGE 200

INTERESTING TO NOTE 5
DEVELOPMENTS TO WATCH ... 9
DESIGN PERSPECTIVES 129
EDITORIAL 133
TECHNICAL NEWS 191
COMING EVENTS 200
NEW COMPONENTS AND MATERIALS ... 216
CATALOGS AND BULLETINS 308
SANS, SOUCI 332
ENGINEERING ABSTRACTS ... 345
NEW BOOKS 353
READERS' LETTERS 365
PRESS PREVIEWS 371



"Armco 17-4 PH Stainless Gives us a Better Product at Lower Cost," Machine Tool Builder says

Serrated dials like this are used on many of the machine tools built by a leading manufacturer. They accurately measure all movements on the tools. So they must be hard, resistant to rust and corrosion, and be finished to extremely close tolerances.

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THIS MONTH'S COVER

Finish rolling heavy coils of copper strip 18 in. wide on a 2-high mill at the Cleveland sheet mill of Chase Brass & Copper Co. For mechanical and chemical methods of coloring and surface treatment of copper and copper alloys, see article in full color on page 135 in this issue.

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Interesting to Note . . .

The Mystery of the Black Stone

WHILE the early history and discovery of magnetism dates back to the Chinese and their first navigational attempts, it is interesting to note how a king's sickness and the coincidental falling of a meteorite some 33 centuries ago gave birth to the worship of a magnet that is prevalent today.

An Arabian tribe, living in the Mecca valley, during pre-Biblical times, was being harried by powerful enemies. At a most critical time the king of the tribe, Ishmael, (son of Abraham and his Egyptian concubine, Hagar) became afflicted with a sudden sickness. Hope for the leader diminished and the people abandoned themselves to prayer. In the midst of a religious proceeding, there appeared a blazing meteor which streamed across the heavens and buried itself in the sands close by the crowd of worshipers. At that instant, legend says, the tribal leader began to recover.

With the passage of time the magnetic stone became an object of increasing reverence. The people of the tribe held that the stone, when touched, possessed mystic qualities for healing sickness. The legend of the "Black Stone" travelled throughout the land and before long robbers attempted its theft. Breaking into the temple, which housed the sacred object, the thieves managed to locate the stone and dislodge it from its granite casing. In their escape, however, they were detected. Filled with rage and knowing that their attempt had failed, the robbers avenged themselves by dashing the stone to pieces on the temple floor.

So Arabian folklore tells us that in fitting together the broken pieces of this Holy Stone, a strange magnetic attraction of the meteoric iron to itself led to the Arabian realization of magnetism. This same stone, showing the cracks which occurred over 30 centuries ago rests today in the Kaaba, a great mosque in the holy city of Mecca.

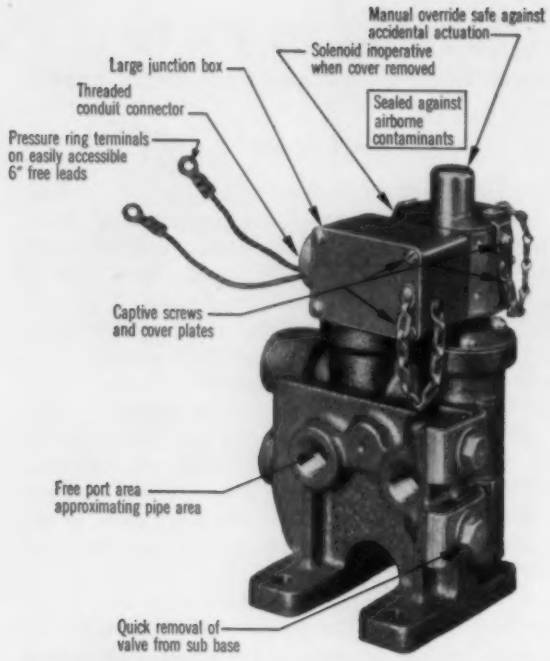
An article on Ceramic Magnets appears on page 143.

Gone Fishin'

ALTHOUGH James Watt is credited with the invention of the steam engine, much of his work was based upon an engine devised by Thomas Newcomen in 1712. Newcomen produced steam by heating water in copper kettles and brewer's furnaces. He then condensed the steam below a piston within a cylinder to create a partial vacuum which would allow atmospheric pressure to force the piston down.

To put this downward pull of the piston to work, he connected a rod to a walking beam and another rod to the piston itself. The vacuum produced by the engine pulled the beam down; when the vacuum was broken, a counterweight on the beam lowered it to its original position. At the end of the beam, Newcomen installed circular arcs over which a rod and chain was attached. As the beam rocked, the rods would rise and fall in a vertical line. To open and close the valves at the

(*Continued on page 7*)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Oil well blow out preventers	Dependability (no freeze-ups) Pressure remains on (leakproof)	Shear-Seal Valves always move freely–after long inoperative periods–or with dirt or pipe scale in the lines No power loss from internal leakage
Your hydraulically operated machine	To improve your product and reduce its cost	Improved CONTROL Save auxiliary equipment and labor Can be modified to suit

Ask for bulletin 0-5

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Interesting to Note . . . .

proper moments a device was attached which controlled them from the motion of the engine. It is said that a boy named Humphrey Potter was supposed to open and close the valves by hand. However, being a boy and liking to fish, he developed a catch or "scoggan" that would trip the valve each time the beam reached the proper position and do his work for him while he went fishing. The "scoggan" not only allowed the boy added recreation, but increased the frequency of the power cycle from eight to sixteen per minute.

Valve design has made significant advances since then. One of many valve types, the relief valve, is the subject of an article on page 174.

Copper, Venus and King Tut

COPPER was introduced to Neolithic man some 7000 years ago, and as in yesteryear, it has remained as one of man's most useful metals. As one of the earliest known elements, legends were bound to arise as man's explanation of the unexplainable. Mythology tells us that Aphrodite (Greek name for the goddess called Venus by the Romans), once rose in all her beauty from the sea's foam off the shore of Cyprus. She requested a looking glass to see for herself the reason for the admiration she perceived in all men's eyes. Not satisfied with gold, for it cast a sallow tinge on her countenance, she chose a mirror of copper. This she felt would brighten the tint of her auburn locks and endow her cheeks with a blush like that of a modest maiden. The mirror of this ancient goddess has become the alchemist's graphic symbol of copper (♀) as well as the symbol for the planet Venus. To the Egyptians, it became a symbol for enduring life. They called it the ANKH which was the middle name of the famous king Tut-ankh-Amen. The ankh may be recognized in any collection of early Egyptian scrolls or inscriptions. Those who are familiar with the charts used by geneticists in making the family trees of plants and animals will recognize the ankh as the female symbol, while a circle with an attached arrow pointing diagonally upward and to the right (♂) is used to designate the male. The same male symbol is the astrological and mythological symbol for Mars, God of War, and the alchemist's sign for iron.

Colored copper, its uses and problems, is the subject of an article appearing on page 135.

The Jail-Breaker's Catechism

ONE hundred and fifty years ago, chromium metal was produced from its ore by the Frenchman, L. N. Vauquelin. Only a few years after Vauquelin's work, two Englishmen, J. Stodart and Michael Faraday, alloyed chromium with iron, which started an international march to find a true stainless steel. In 1865 a Brooklyn manufacturer named Baur obtained a patent for a chromium steel which was advertised as a high-strength steel for burglar-proof safes and cells. His literature portrayed a dejected desperado behind "chrome steel" bars, bearing the caption: "The Jail-Breaker's Catechism."

The claims of Baur aroused so much controversy that an American metallurgist, H. M. Howe, went to the point of saying that no chromium could be found even in the slag of the Brooklyn Steel Works. In countering the charges against him, Baur claimed to have supplied chromium steel for the bridge built by Capt. J. D. Eads, which spans the Mississippi River at St. Louis. Intrigued by this controversy, a French metallurgist Brustlein experimented with chromium and introduced a series of true chromium steels.

In 1916, while trying to develop a more erosion resistant iron-base gun barrel lining, Harry Brearley developed and patented a "ferrous alloy containing approximately 0.30 per cent carbon; 0.3 per cent manganese and 13.0 per cent chromium." Although no one man can be credited with the discovery of stainless, Brearley's work has had major influence in the modern development of stainless steels.

Details on a new member of the stainless steel family may be found in an article on page 151.

Frog's Legs

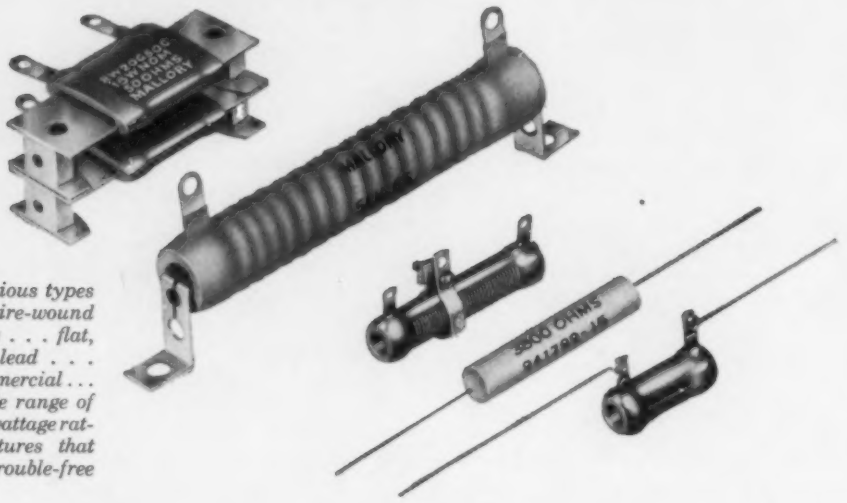
IT is strange to associate the experiments of an anatomy professor with the development of the electric "pile" or wet battery, but the early phenomenon of "animal electricity" discovered by Luigi Galvani led directly to Alessandro Volta's great contribution to the electrical sciences. Galvani reported in 1791 that while dissecting a frog, a discharge from a neighboring electrostatic generator had caused the frog's dissected legs to jerk spasmodically. The scientific world was most interested in the experiments of this mild mannered professor at the University of Bologna. However, it was Volta, a physics professor at Pavia who, upon repetition of Galvani's experiments, hypothesized that the electric source did not originate in the tissue of the frog, but from the contact of dissimilar metals.

In a letter to the Royal Society of London in 1800, Volta described an electrical producing apparatus he developed whose action compared to the Leyden jar. Although Volta's "battery" was somewhat weaker than the discharge from the Leyden jar, it offered a continuous flow of electricity.

Volta's discovery was revolutionary. He was invited to Paris to demonstrate his device before Napoleon, while scientists throughout the world were given their first source of constant flow electricity. The terms "galvanic cell" and "volt" ever perpetuate the names of these two great scientists.

Fundamentally of an electrolytic nature, corrosion of dissimilar metals is the topic of an article on page 187.

MALLORY



Each of the various types of Mallory wire-wound power resistors . . . flat, tubular, axial lead . . . military or commercial . . . comes in a wide range of resistance and wattage ratings, with features that assure long, trouble-free service.

Mallory Power Resistors

with the Performance and Ratings You Need

Need wire-wound power resistors? Look to Mallory for performance to meet your specifications . . . types and ratings to match your circuits. A wide line gives you extensive selection.

RW Military Types to meet the requirements of MIL-R-26B, characteristics G and V, include classifications RW20 through RW24, RW29 through RW39 and RW49. Each is available in a broad range of resistances and wattages.

Commercial Vitreous Enamel Tubular Resistors cover wattage ratings from 3 to 200 watts.

Axial Lead Resistors, 4 and 7 watt sizes, are especially designed for economical use in television and other commercial electronic applications.

Adjustable Vitreous Enamel Resistors, in ratings up to 200 watts, feature a special construction to hold the element securely in place to prevent shorting between turns.

Cement Coated Resistors, designed for use where resistance to extreme humidity is not needed, offer good service at economical cost. 5 to 200 watts, in many resistance values.

Mallory resistors incorporate many design features to assure superior life, high physical strength and ability to stand thermal shock. The vitreous enamel coating is a special, non-alkaline material, sealing the wire element in a uniform coating that prevents entry of moisture and electrolytic corrosion.

A consultation with a Mallory resistor specialist can help you select the types best suited to your specific circuit requirements. For data, write to Mallory for Catalog 79-8.

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Developments

To Watch

A REAL OIL-LESS, SELF-LUBRICATING BEARING METAL . . . .

. . . . called Deva-Metal is made from a combination of metal powder and graphite, and no impregnated oil. In place of the oil film on conventional powder metal bearings, the Deva-Metal bearing has a graphite film. The graphite content of this metal may vary from 6 to 25 per cent by weight, depending upon the particular application. This compares with the maximum graphite content of 2 per cent used in the sintered powder metal "oil-less," or oil-containing bearing.

A variety of metal bases have been used, such as: bronze (with or without lead); brass; iron, and nickel. After a uniform distribution of the graphite in the metal powder, the material is put into a preform. In the next step, the final hot compacting step is done at from 1325 F to 2000 F, depending upon the metal powder, to get the high strength of the bearing. There is no sintering process after this. The hot compacting step produces a bearing of full density. Present cold compacted powder metal bearings have approximately 80 per cent density, with the remaining 20 per cent of voids impregnated with oil.

The operating temperature range of the new bearing metals are: —300 to 750 F for a bronze base; —300 to 400 F for a leaded bronze base; —300 to 400 F for a brass base; —300 to 750 F for a nickel base; and —300 to 1250 F for an iron base. Other advantages are: good running properties with negligible abrasion; minimum of starting difficulties; good resistance to corrosion, since a variety of metal powders can be used and graphite is in sufficient quantity to add corrosion resistance; and a large range of temperatures and pressures. As the graphite content increases, the radial crushing strength decreases. For example, average crushing strength values of a bronze base Deva-Metal with an 8 per cent graphite content is 45,000 psi; and 14,800 psi for a 15 per cent graphite content. For an iron base metal, the average crushing strength values drop from 51,000 psi with 6 per cent graphite, to 16,200 psi at 12 per cent graphite. Drawbacks to the new metal are: the costlier raw materials necessary; more costly and slower processing techniques; and slower production rates since the material cannot be made with the same techniques used in mass producing sintered bushings. U. S. manufacturer and licensee of this German development is the Deva-Metal Corp., P. O. Box 146, Ridgewood, N. J.

HARD SURFACING OF STAINLESS STEEL PARTS . . . .

. . . . by a process called Supercase is reported to be particularly adaptable to parts requiring maximum corrosion resistance. With depths controlled to closer limits than by older methods, and with a hard case, only a light case is required. Normal case depth using this process ranges between 0.003 to 0.007 in. Supercase may be removed, the parts reworked, and then re-nitrided. In addition, the hard surfacing may be done on a selective basis. If it is necessary to machine an area further after the nitriding, this part can be masked off and will remain soft after processing. The process can be used on martensitic, ferritic, as well as austenitic stainless steel.

NON-DESTRUCTIVE TESTING OF RESISTORS . . . .

. . . . used in electronic equipment requiring high reliability is being investigated by the Armour Research Foundation of the Illinois Institute of Technology, Chicago 16, Ill., for the Air Materiel Command at Wright Field. Present destructive methods of evaluating resistors preclude 100 per cent testing. Work at Armour

(*Continued on page 10*)

is directed toward finding non-destructive tests which give results that correlate with destructive type tests. The non-destructive type tests are based on electrical noise, effects of short time overload current, change of resistance with voltage, change of resistance with temperature, X-ray techniques, and other principles to help to determine the quality of materials and construction. The non-destructive testing procedure is expected to be faster, more accurate, and less expensive. Such a philosophy might be expanded to all electrical components.

VIBRATION TIGHTENS, NOT LOOSENS THIS NUT . . . .

. . . . when the part to which it is attached is subjected to vibration. The nut is built up from a stack of resilient metal disks that are assembled in the hollow body, then drilled and tapped. As the nut is tightened, the conical disks are axially compressed, forcing their outer edges slightly outward. The inner edges of the disks are wedged into complete contact with the bolt threads. Any variable load will tend to increase the pressure between the disks and the bolt threads, resulting in a self-tightening action. The nut undergoes no permanent deformation, and can be unscrewed or adjusted at any time. The manufacturer is Lester Lock & Washer Co., Ltd., Camp Hill Works, Wordsley, Staffs., England.

EXPANDING AND CONTRACTING WITH ALTITUDE CHANGES . . . .

. . . . an air-tight, fibrous plastic container does not require pressure relief valves which are necessary to relieve the internal pressure at high altitude of air-tight metal containers carrying military components. The container was developed by the Pressure Form Container Corp., Swarthmore, Pa., with their new pre-form process for fibrous reinforced plastic. Besides eliminating the pressure relief valve necessary on metal containers, the plastic containers have good resistance to rust and mildew, feature light weight, and will absorb impact without distortion. The containers meet specification MIL-P-116B.

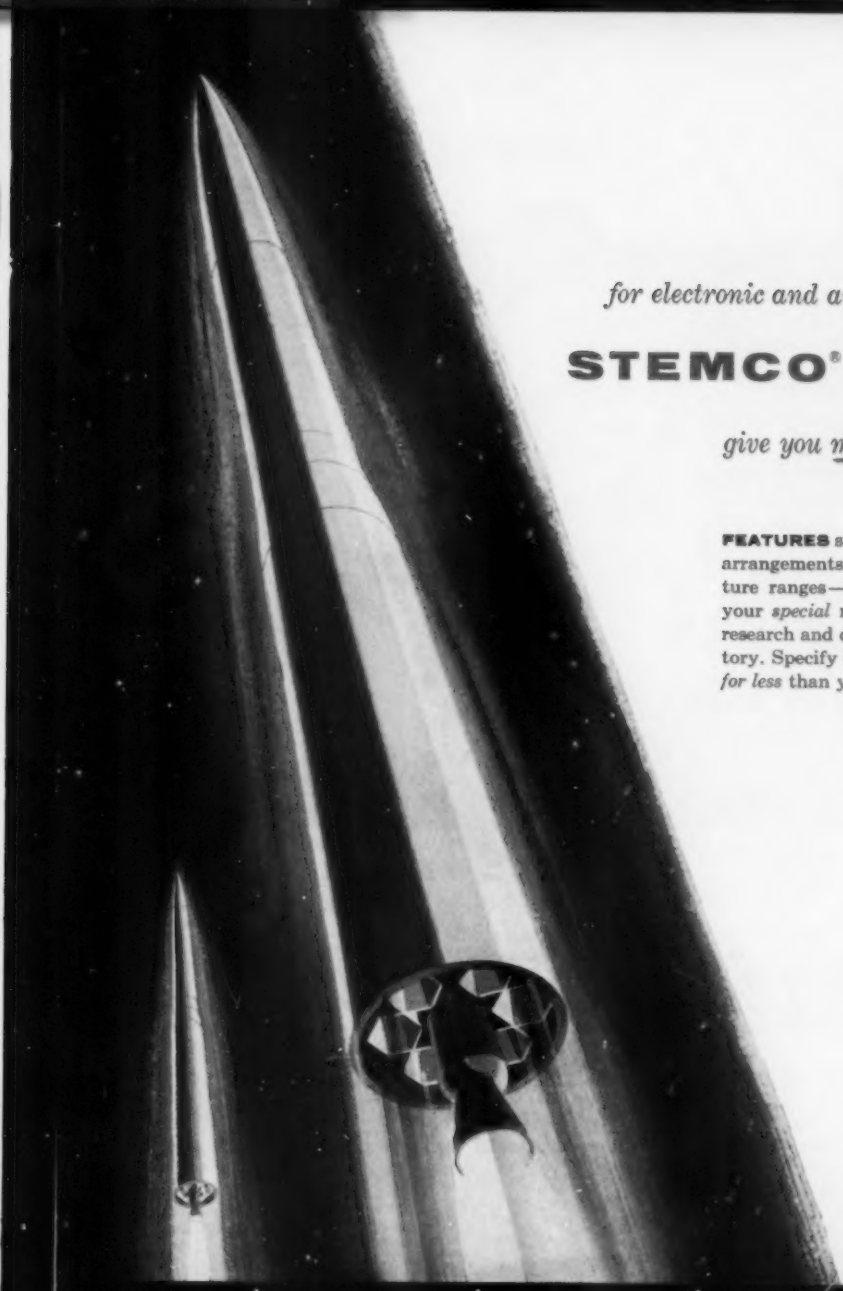
A HIGH DENSITY ALLOY FOR HIGH ROTOR SPEEDS . . . .

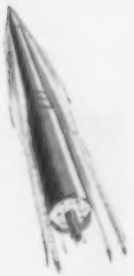
. . . . of gyroscopes is said to have higher stability and strength than previously obtainable, and will take rotor speeds about 25 per cent higher than permissible with other materials. Developed by P. R. Mallory & Co., Inc., Indianapolis 6, Ind., the material is called Mallory 1000 Gyromet and has a density of 16.70-17.05-gm/cc. Its proportional elastic limit is 62,000 psi; modulus of elasticity in tension, 44 x 10^6 psi; endurance limit, 55,000 psi. Gyromet is a sintered alloy of tungsten, nickel, copper, and other elements, is machinable, and is available in varied stock forms and sizes. Rotors of higher speed and smaller size are possible, and the material's greater stability suggest such applications as inertial guidance systems.

AUTOMATIC MOLDING SYSTEM FOR SAND CASTINGS . . . .

. . . . is capable of producing at least 240 completed molds per hour when operated by a five-man team. Heart of the system is the automatic molding machine which prepares the molds in their boxes. The completed molds are then automatically positioned on a rotary conveyor for pouring, which is done by a specially designed mechanism arranged to eliminate operator fatigue. The sand used in forming the mold moves through a continuous cycle. After it has been made into a mold on the main machine and has been in contact with the molten metal, it is removed

(*Continued on page 13*)





for electronic and avionic devices

STEMCO® THERMOSTATS

give you more of what you want most

FEATURES such as snap or positive-action . . . various terminal arrangements or mounting provisions . . . different temperature ranges—there's a *standard* type Stemco thermostat for your *special* needs. That means you cut down on lead time, research and development costs, tooling and production inventory. Specify Stemco and you get *better thermostats, faster and for less* than you can make them or buy them elsewhere.

SIZE and weight are particularly important in avionic and electronic applications. And here Stemco thermostats score, too. Their compactness and lightness give a better product without sacrificing performance.

ECONOMY of mass production of many standard Stemco types with literally hundreds of terminal arrangements and mounting provisions means your product costs less to make.

AVAILABILITY of most types is good. Design is flexible for your special applications, tooling is in existence for short-term delivery. If heat control is your problem, Stemco thermostats can provide the answer.

AA-4092

**Refer to Guide 400 EO for U.L. and C.S.A. approved ratings.*

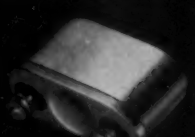
STEVENS *manufacturing company, inc.*
Lexington and Mansfield, Ohio

TYPE A*
Semi-enclosed

Insulated, electrically independent bimetal disc gives fast response and quick, snap-action control. Operation from –10° to 400°F or higher on special order. Various mountings and terminals. Average rating 6½ amps at 115 volts AC, 4 amps at 230 volts AC and 28 volts DC. See Bulletin 3000.

TYPE A*
Hermetically sealed

Electrically identical to semi-enclosed Type A. Temperatures from –10° to 300°F. Various enclosures and mountings, including brackets, available. For appliance, electronic, apparatus applications. Bulletin 3000.



TYPE C
Hermetically sealed

Electrically identical to semi-enclosed Type C but sealed in crystal can. Also supplied as double thermostat "alarm" type. Turret terminals or wire leads. Request Bulletin 5000.

TYPE C
Semi-enclosed

Small, positive-acting. Electrically independent bimetal strip for operation from –10° to 300°F. Rated at approximately 3 amps, depending on application. Terminals and mountings to customer specifications. See Bulletin 5000.

TYPE M*
Semi-enclosed

Electrically independent bimetal disc type for appliance and electronic applications from –10° to 350°F. Rating: 8 amps at 115 volts AC, 4 amps at 230 volts AC and 28 volts DC. Virtually any type terminal. Bulletin 6000.

TYPE M*
Hermetically sealed

Electrically same as semi-enclosed Type M. Can be furnished with pin or solder-type terminals, wire leads and various mounting brackets. Write for Bulletin 6000.

STEMCO® THERMOSTATS

It's not just static strength...

RESISTANCE TO TENSILE STRESS is achieved by use of properly heat-treated, accurately-machined side bars made of premium steel and fitted with properly-hardened pins, bushings and rollers. But to resist *operational* stresses, additional controls over dimensional accuracy, uniformity and roller resiliency are essential.

STRENGTH OF CHAIN IN MOTION is accomplished through tensile strength *plus* special Link-Belt refinements. These include pitch-hole preparation, micro-finish of parts, special processing of sidebars, prelubrication and rigid quality control from initial selection of materials to final protective boxing.

it's *dynamic strength*

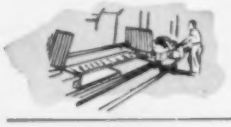
in LINK-BELT Roller Chain that fights fatigue

On high-speed, heavy-duty equipment, every roller chain component faces severe operating stresses — engagement with sprockets, shock of starting loads, centrifugal loads and others. That's why *dynamic strength*—ability of chain to resist these stresses—is so important. And it's built into *every length* of Link-Belt Precision Steel Roller Chain through special design, manufacturing and processing steps —providing required properties of uniformity and accuracy for long-life operation.

Let your Link-Belt office explain what dynamic strength can mean to the performance of your machine. And ask for Book 2457, covering this complete line of single and multiple widths, in ¼ to 3-inch standard pitch, 1 to 3-inch double pitch.

14.277

LINK-BELT gives you dynamic strength that comes from these important EXTRAS



PRE-STRESSING of multiple width chain provides uniform load distribution.

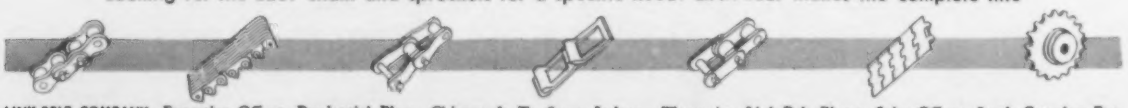
SHOT-PEENED ROLLERS have greater fatigue life, added ability to withstand impact.

LOCK-TYPE BUSHINGS (applied on a range of sizes) end a cause of stiff chain.

LINK-BELT

ROLLER CHAINS & SPROCKETS

Looking for the BEST chain and sprockets for a specific need? LINK-BELT makes the complete line



LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office: New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World.

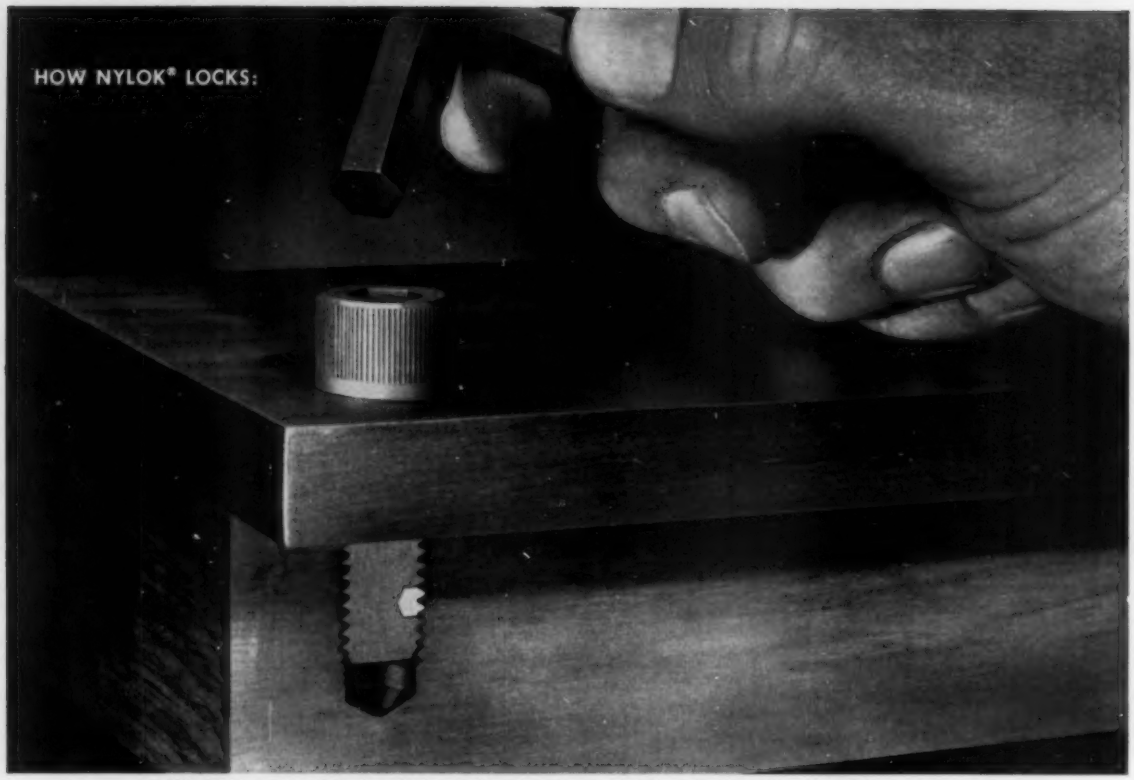
from the casting at the "shake-out" position and returned by an underground conveyor to a conditioning plant. The sand eventually returns to a hopper and measuring device before it is re-used in the molding boxes. Molding boxes measuring 12 in. by 9 in. by 5 in. are used and it is estimated that an output of 1000 lb per man per day is possible. The system was developed at Rubery Owen & Co., Ltd., Darleston, Staffs., England.

A HIGH-STRENGTH ALUMINUM BRONZE ALLOY . . . .

. . . . with a higher yield strength, greater toughness (Izod notched impact strength is 18 to 30 ft-lb), and longer fatigue life than any known alloy of its kind will be produced for the first time in this country by American Brake Shoe's National Bearing Div., St. Louis, Mo., and Ampco Metal, Inc., Milwaukee, Wisc. A new company, Superston Corp. (after the alloy Superston 40) will be formed by the above two companies and the alloy's British developer J. Stone & Co., Ltd., London, England. Superston 40, a two-phase (alpha-beta) alloy, contains about 12 per cent manganese, 75 per cent copper, 8 per cent aluminum, 2 per cent nickel, and 3 per cent iron. The metal melts at 1814 F, flows readily when casting thin vanes as well as heavy sections, and can be easily forged, rolled, or extruded. Average values for sand castings, tensile strength, 98,000-psi; yield strength at 0.5 per cent elongation, 48,000 psi; Brinell hardness (10 mm ball, 3000 kg load) 185. For centrifugal casting, the tensile and yield strengthens are increased to 105,000 psi and 50,000 psi respectively. Wrought products of Superston 40, which is a good hot working alloy have tensile strengths up to 135,000 psi and yield strengths to 85,000 psi. Brinell hardness ranges from 180 to 230. Elongation in 2 in. range from 35 to 15 per cent. Cold working unless followed by interstage annealing is limited to cold drawing for sizing after extrusion. Using centrifugal casting, 3 in. thick castings, up to 20 in. in dia, and 12 ft long have been spun successfully. Prices are expected to be comparable to high quality aluminum bronze.

AND IN ADDITION . . . .

. . . . Titanium strip in thicknesses down to 0.001 in. is available from the American Silver Co., Inc., Flushing 54, N. Y., in tolerances as close as ±0.0001 in., in widths from ⅛ to 6 in., and in quantities from one pound to thousands; one application is for high temperature honeycomb structures . . . . A "burial" tunnel 500 ft long has been constructed at General Electric's Hanford, Washington atomic energy plant for the disposal of equipment too radioactively hot to be repaired and too heavy to be hauled away for burial; such equipment is loaded on a flat car and rolled into the tunnel . . . . The Westinghouse Electric small motor division, Lima, Ohio, has increased prices by 7½ per cent on almost all fractional horsepower motors, including laundry equipment and home workshop motors; renewal parts prices for these motors have been upped 10 per cent . . . . The Small Business Administration and the U. S. Dept. of Commerce announced joint action to increase the volume of Commerce Dept. contract awards to small firms . . . . A program is being conducted to establish criteria to predict the deterioration in performances of electronic equipment due to the presence of quantities of certain chemical dust particles in the air . . . . General Electric recently shipped its first gas-filled power transformer, rated at 2000 kva, and expects that this new medium for cooling transformers to lead to lighter, safer, and quieter transformers in the future; the gas used is sulfur-hexafluoride, advantages are lighter weight (a 10,000 kva gas-filled unit would weigh about 2000 lb less than an oil-filled unit); greater safety from fire; and quieter operation.



LOCKED! The tough, resilient nylon pellet keys itself into the mating threads. It forces threads together, and locks the screw securely.

NEW—a complete line of self-locking UNBRAKO socket screw products that won't work loose

They simplify design and save production time

UNBRAKO socket screws are now available embodying the Nylok® self-locking principle. Nylok provides a truly practical new solution to the problem of making screws self-locking.

You save production time when you build products with self-locking UNBRAKOS. And you get greater simplicity in design with less bulk and weight. The number of parts you must assemble to achieve full locking action is reduced to the absolute minimum. Lockwashers under screw heads are no longer necessary. Costly wiring of cross drilled heads is eliminated. So are cotter pins and complex multiple set screw installations.

Self-Locking UNBRAKOS are completely reusable. They have uniform locking and installation torques—with no galling or seizing on mating threads. They successfully withstand temperatures from —70° to 250°F. And, on properly seated screws, the pellet acts as a liquid seal.

Self-locking UNBRAKO socket screws come in a complete range of standard sizes and materials. See your authorized industrial distributor. Technical data and specifications are detailed in Bulletin 2193. Write us for your copy today. Unbrako Socket Screw Division, STANDARD PRESSED STEEL CO., Jenkintown 28, Pa.

T.M. Reg. U.S. Pat. Off., The Nylok Corporation

UNBRAKO SOCKET SCREW DIVISION

STANDARD PRESSED STEEL CO.

SPS

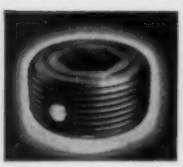
JENKINTOWN PENNSYLVANIA

Socket head cap screws. Standard sizes #6 to 1 in.

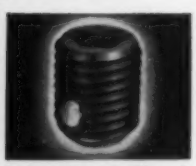
Socket shoulder screws. Standard sizes ¼ to ⅜ in.

Flat head socket screws. Standard sizes #6 to ⅜ in.

Button head socket screws. #6 to ⅜ in.



Socket pressure plugs. Standard sizes ⅛ to 1¼ in.



Socket set screws. All standard point types. #6 to 1 in.

Why close tolerances in resilient gaskets are rarely necessary

Tolerances in the size and shape of a gasket do not become critical if the material chosen seals effectively over a wide range of compressions.

Armstrong Cork-and-Rubber Compounds are typical of such wide range materials. They seal tightly under compressions ranging from 20% to 33%. As a result, tolerances in the size of the gasket can be as wide as ±.010". In some applications, the wider tolerances permissible with compressible gasket materials may effect savings in machining time.

Confined applications

Cork-and-rubber's wide compression range—and the resultant wide tolerances possible—is particularly valuable in confined gasket applications. Because these materials are truly compressible, they decrease in volume under load. This enables cork-and-rubber gaskets made slightly oversize to compress into a completely confined space. The absence of side flow makes it easy to mate flanges perfectly.

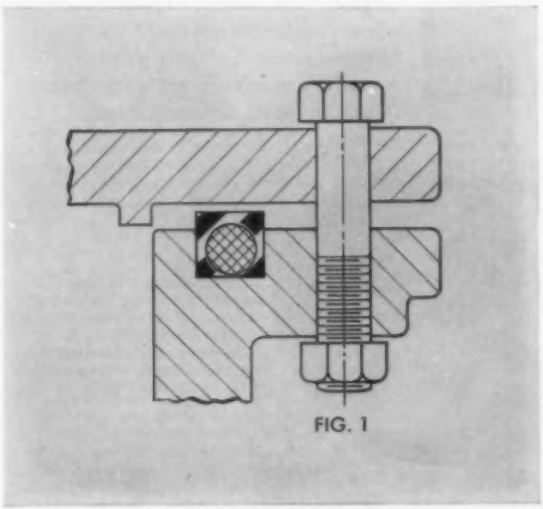


FIG. 1

Figure 1, for example, illustrates the relative sizes of a cork-and-rubber gasket and a comparable non-compressible molded ring. The resilient cork-and-rubber compound permits wide tolerance in its size, whereas the molded ring must be made to very close tolerances to allow perfect fit between the flanges.

Similarly, in figure 2, wide tolerance cork-and-rubber gaskets make an effective packing ring. Their true compressibility controls lateral flow and prevents excessive build-up of radial pressure on the shaft.

Metal-to-metal joints

When non-compressible rings were used on the flanged journal of the calender roll shown in figure 3, extremely close tolerances were required. Undersized rings leaked. Oversized rings prevented metal-to-metal contact between the flanges and caused misalignment. Both of these problems were solved with the use of standard tolerance cork-and-rubber rings, which fitted perfectly and sealed tightly.

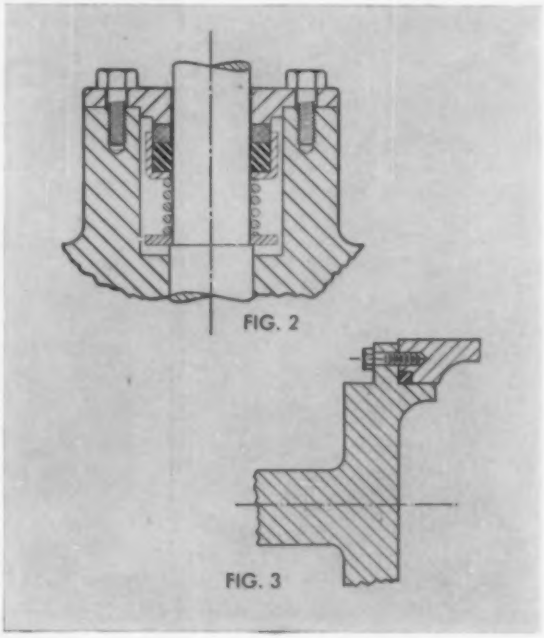


FIG. 2

FIG. 3

We recommend that you discuss specific sealing problems with an Armstrong representative. Methods and materials he may suggest may help you reduce production time and lower costs.

SEND FOR 24-PAGE GASKET MANUAL

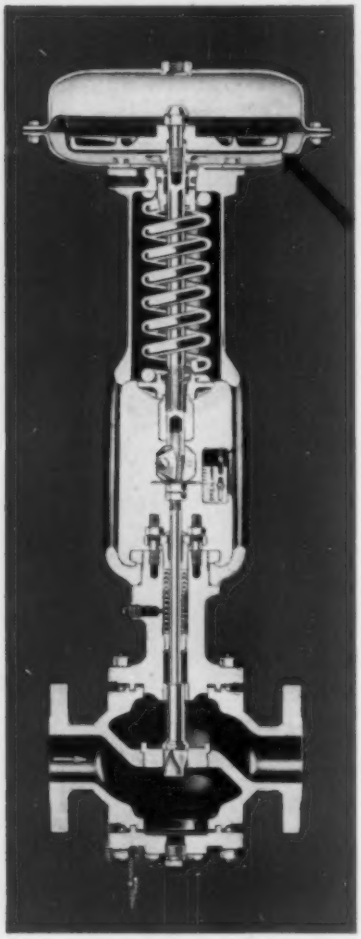
You'll find other useful information on the design and use of gaskets in the new Armstrong Gasket Design Manual. Write for your copy of this manual to Armstrong Cork Co., Industrial Division, 7112 Irvin Street, Lancaster, Pa.

Armstrong

GASKET MATERIALS

. . . used wherever performance counts

Engineered Rubber Products



Mass-produced to exacting specifications

this U. S. Rubber Molded Diaphragm is a constant "watchman" on leading motor valves.

Where consistency is vital in controlling the flow of liquid through piping systems, leading makers of motor valves specify "U. S." molded diaphragms because "U. S." experts mold them to their exacting specifications.

High burst resistance, retention of "molded in" shape under high pressures, exact fabric placement to prevent fabric exposure and resultant "wicking" action are just some of the exacting requirements fulfilled by "U. S." molded diaphragms.

Yet, this is only one of hundreds of applications wherein U. S. Engineered Rubber Products *do jobs no other material can do.* "U. S." factory-trained engineers will help you solve any molded rubber problem. Contact us at Rockefeller Center, New York 20, N. Y.

U. S. Molded Milking Inflation has three times the wear of previous ones, thanks to a combination of quality molding and a new rubber compound.

U. S. Molded Piston Rubber for oil rig slush pumps. Lasts 3 times longer than previous piston rubber. Fits snugly to inside of cylinder, yet easily replaceable.

U. S. Molded Reel Seals protect the working mechanism of rayon spinning reels from acid corrosion. Made to a tolerance of .005 of an inch, they are continually flexed 24 hours a day, month after month.

Mechanical Goods Division

United States Rubber

Watch NCAA football, Saturday afternoons, NBC-TV

NEW Stock-Control System based on VEEDER-ROOT Vary-Tallies

saves time...
speeds production...
stops errors

Manufacturers of skirts (or skis) can speed and simplify their stock-keeping, accounting, and payroll records with simple punched-card systems based on Vary-Tallies. A leading skirt-maker, for instance, always has complete command of several variations of styles, sizes and colors simply by lifting out the cards for any of these classifications . . . and recording them on the Vary-Tally. This gives him an instant accounting on any account, without pencil tallies, scratch marks, or telltale marks on the goods.

In time-checking, this manufacturer has tallied 420 items on 80 orders in 4½ minutes. *His best previous time was 40 minutes.* No copying . . . nothing but the final totals on the counter-faces.

What Production Systems Inc., Waltham, Mass., is doing for the garment industry with its "Quik-Pik" System . . . *you* can do for yourself with a similar system based on Vary-Tallies. And you can count on Veeder-Root to help you. Write:

Hartford, Conn. • Greenville, S. C. • Chicago
New York • Los Angeles • San Francisco • Montreal
Offices and Agents in Other Principal Cities

VEEDER-ROOT INC.
"The Name that Counts"

Craftsmanship of the 20th Century

MONSANTO

The speed with which new products pass through the designing stage to final marketing is one of today's industrial phenomena. One factor which has contributed heavily to this is the availability of a wide range of plastic materials with highly usable combinations of properties. And, collaterally, there are the custom molders whose working knowledge and craftsmanship in plastics translate the manufacturer's designs and plans into highly serviceable, highly attractive finished articles. Read how one of America's leading appliance manufacturers collaborated with the custom molder to produce the part that "makes" his new appliance.

New handle of Resinox phenolic plastic houses "the brain" of the new Sunbeam Fry-Pan

DESIGN OBJECTIVES To design the handle for the Sunbeam Fry-Pan, an aluminum frying pan, electrically wired to "do its own cooking." To its designers, Sunbeam Corporation of Chicago stressed two things: functional beauty and long service life. Cost, of course, as on all high-volume competitive products, was also a consideration.

MATERIAL SPECIFICATION In the Fry-Pan, the handle is the "brain"—housing the temperature setting controls, signal light, and automatic regulators that govern the 1150 and 1450 watt tubular element sealed in the base of the pan. Specifications dictated that this handle be inserted into the apertures of the thermostat, then sealed in 3 seconds by a Hannifin hydraulic press. Over 30 exhaustive tests were made to screen different materials in the conditions to which the handle would be subjected in use. Surface finish and hardness, resistance to detergents and boiling water, weight, dielectric strength, and durability were all major factors in determining the material. Monsanto Resinox phenolic plastic was selected. A handle molded of this phenolic had a high natural surface gloss, heat-resistance, and inherent color. It could be repeatedly immersed in boiling water with no ill effects . . . was tough and long lasting.

Chief Mold Designer for Prolon Plastics Co., Mr. Clyde Morrell.

PRODUCTION Prolon Plastics Company, Florence, Massachusetts, a division of Pro-phy-lac-tic Brush Company, was awarded the job of producing the Fry-Pan handles. In addition to an enviable reputation for high quality molding, Prolon had also demonstrated a productive capacity to meet Sunbeam's production rate. For this handle assignment, Prolon engineers decided on Monsanto Resinox 5797. A free-flowing phenolic molding compound, Resinox 5797 has rapid cure and rigid set, two reasons for its wide use for wiring device parts. It produces parts with a very smooth,

hard surface. Equally important, Resinox 5797 meets the critical heat requirements on the Fry-Pan where heat is constantly re-applied to this molded handle. Using Resinox 5797, Prolon molded a handle with a life expectancy far exceeding the required 2000 hours. In fact, if the housewife uses her Sunbeam Fry-Pan with its Resinox handle for 7 hours a week, 52 weeks of the year, she can expect over 5½ years of service under such severe usage.

THE FINISHED PRODUCT The popularity of the Sunbeam automatic Fry-Pan is a tribute to the usefulness of this work-saving kitchen appliance. Practical usefulness has been achieved by following the precepts of functional design and simplicity of form. The jet black lustrous handle of Resinox phenolic plastic adds a high note of functional beauty.

Here is one of the hundreds of design and production problems solved by utilizing the facilities of the plastics custom molding industry. If you are considering a design change or new product, investigate plastics, and the design, engineering, and molding facilities available to you through plastics molders, the Craftsmen of the 20th Century. As a major supplier of plastic resins, Monsanto is in a position to introduce you to custom molders who will put their skills to work for you. Write to Monsanto Chemical Co., Industrial Applications Dept., Springfield 2, Mass.

Investigate Monsanto's complete line of phenolic plastic compounds developed for particular applications and sold under the trade name...

RESINOX®

MONSANTO

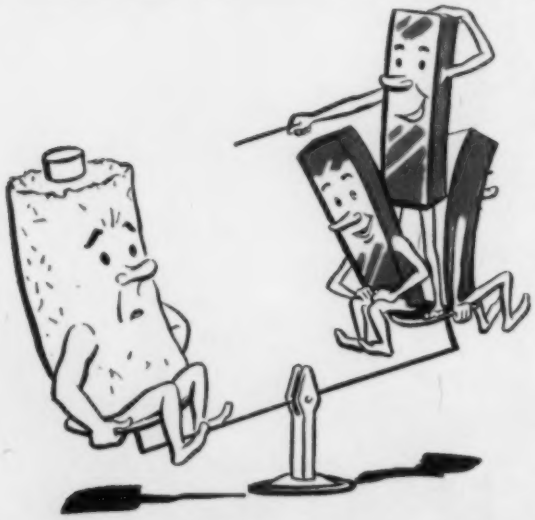
What magnet wire characteristics do you need?

The most important single element you choose for any piece of electro-magnetic equipment is the magnet wire. That's why you have a right to demand that your magnet wire has exactly the properties you need. The need for better and better magnet wire—for use in General Electric equipment as well as yours—is the reason why General Electric introduced Formex*, the revolutionary film-type magnet wire, in the late 1930's; why the various types of high-temperature Deltabeston* wire were developed; and why, in 1955, Alkanex† magnet wire was announced—providing the industry with a film-type wire which would operate at copper temperatures up to 150 C.

To meet your requirements—high temperature operation, compactness, light weight, flexibility, economy—General Electric offers a complete line of magnet wire types, shapes, and sizes.

Write General Electric Company, Wire and Cable Department, Section W188-1267, Bridgeport 2, Conn.

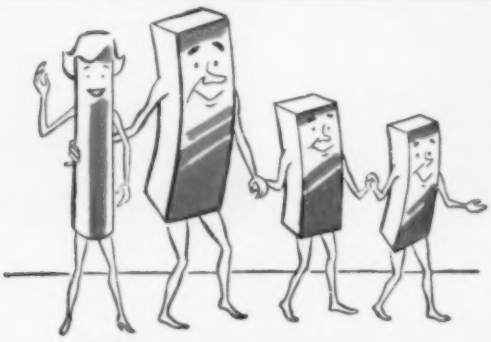
HEAT RESISTANCE— Formex has greater resistance to heat than ordinary enameled wire, and is recommended for Class A applications up to 105 C. Alkanex raises limiting operating temperatures up to 150 C for motors and other types of electrical apparatus which require the compactness of a film-insulated magnet wire. Deltabeston, with either asbestos or glass insulation, has wide use in Class B applications for temperatures up to 130 C. When impregnated with silicone varnish, Deltabeston meets the requirements of Class H applications—for temperatures up to 180 C.



LESS SPACE AND WEIGHT— Formex takes less space than fibrous-covered or fibrous-covered-enameled wire. Formex also saves weight because there are more feet per pound than in fibrous-insulated types, especially in the finer sizes where, for example, 15,000 feet per pound of No. 37 Awg heavy Formex wire compares with only 11,600 feet per pound of enameled single-cotton. Alkanex, however, with its extremely high operating temperature can make the most of the space you allow for the winding and still take the extra heat. The higher limit makes possible lighter, as well as more compact, motors—since the use of Alkanex wire can increase a motor's horsepower rating as much as 25%.

GOOD MECHANICAL PROPERTIES
Formex has greater toughness and flexibility than any conventional type of enameled wire. Alkanex is similar to Formex in its high dielectric properties. It also has excellent abrasion resistance, chemical resistance, adhesion, and mechanical strength. For unsurpassed performance where grease, oil, or corrosive vapors are present, Deltabeston is the choice—with either asbestos or glass insulation.

MOISTURE RESISTANCE— Formex and Alkanex are outstanding in two important factors most responsible for the influence of moisture on magnet wire: (1) resistance to moisture absorption, and (2) continuity of the insulating film. Properly treated insulation of both types is highly resistant to moisture absorption. Toughness and flexibility maintain film continuity after winding.



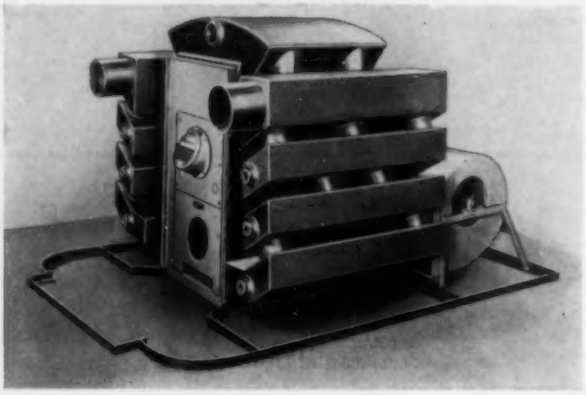
AVAILABILITY— Formex and Deltabeston are available in round, square, and rectangular shapes, and in a complete range of sizes. Alkanex is available in round size No. 13 Awg through No. 26 Awg with single and heavy-wall film thicknesses. Development of other sizes and shapes is under way.

**Registered Trade-mark General Electric Company*
†Trade-mark registration applied for by General Electric Company

Progress Is Our Most Important Product

GENERAL ELECTRIC

Alloy steel cap screws



SAFE, GAS-TIGHT JOINTS required by the down-flow construction of this year-round furnace and air-conditioning unit are easy to obtain, using Republic ELECTRUNITE® Mechanical Tubing. Its uniform roundness, wall thickness, strength and ductility help simplify design and fabrication. Quality control from raw ore to finished product assures long, trouble-free service.

REPUBLIC

REPUBLIC STEEL

World's Widest Range of Standard Steels

assure hermetic seal permanence

One of the most critical points in maintaining an absolute hermetic seal in any refrigeration system is the joint between compressor cylinder and head. That's why Copeland Refrigeration Corporation of Sidney, Ohio, manufacturer of fine commercial refrigeration and air conditioning compressors, insists on cylinder head cap screws made to exacting specifications. Republic Alloy Steel Hex Head Cap Screws fill the bill perfectly. They more than meet tensile strength, yield point, hardness and ductility requirements.

Design of the Copeland Compressor calls for cap screws to clamp cylinder head, a neoprene gasket, valve plate, another neoprene gasket and cylinder block into one solid, leakproof assembly. Year-in, year-out service dependability demands that these fasteners neither stretch nor lose their grip under the heating and cooling cycle of on-off operation. There must be no loss in compression or escape of refrigerant. Again, Republic Alloy Cap Screws are more than equal to the task—as proved by their failure-free performance record.

Whatever your fastener problem, it will pay you to check Republic. 20,000 standard and 8,000 special types and sizes of headed and threaded products are available to satisfy a tremendous variety of applications. Each is backed by a century of experience, and quality controlled from raw ore to finished product.

You can get complete information through your local Republic office. Or simply mail the coupon.

OUTSTANDING PRODUCT PERFORMANCE is assured when you specify Republic Hot Rolled Carbon or Alloy Bars as your raw material. A full range of standard and special shapes, sizes and grades is available to meet the most exacting requirements. Further, Republic's 3-Dimension Metallurgical Service can help you select the proper type, and process it efficiently.

ZINC COATING PERMANENCE makes Republic Continuous Galvanized Sheet ideal for hundreds of mass-produced parts and products. Its uniform, corrosion-resistant zinc coating will not crack, flake or peel under any forming operations permitted by the base metal. Resulting product is far less expensive to produce than old-fashioned, hot-dipping after fabrication would allow. Send coupon for information.

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Cleveland 27, Ohio

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☐ Fastener Products ☐ Continuous Galvanized Sheets
☐ ELECTRUNITE Mechanical Tubing ☐ Hot Rolled Bars

Name_____ Title_____

Company_____

Address_____

City_____ Zone____ State_____

HOW USS "T-1" STEEL IMPROVES ...THESE PRODUCTS...

Pays Off In Payloader. Speed is emphasized in International Harvester's new Model 12 Payloader. That means weight had to be cut. And USS "T-1" Steel helped cut weight of the rugged boom. This remarkably tough, strong steel is used at top and bottom sides where maximum stresses are imposed. The section depth of the USS "T-1" Steel parts is 12 inches. With other, less strong steels, section depths of 19 and 24 inches would have been required—much too large to fit the contour of the machine. USS "T-1" Steel cut size, weight . . . was cold bent, and welded to other parts of the machine by automatic submerged arc welding.

Stops Brake Breakage. Columbiana Cylinder Grinding Company, Columbiana, Ohio, does a lot of custom machining on industrial and mining equipment, including repair of brake and clutch bands for large earthmoving equipment. On the original equipment these bands are made of plain mild steel . . . often break under the tremendous stresses encountered. Columbiana replaces broken bands with new ones of USS "T-1" Steel—has yet to have a USS "T-1" Steel band break.

More Strength, Less Weight. This lift truck, in use at Baltimore Concrete Plant Corporation, and manufactured by Gerlinger Carrier Company, Dallas, Oregon, is the largest standard-line lift truck on pneumatic tires in the world. USS "T-1" Steel reduced the width and thickness of the forks on this truck. In addition, this extremely tough constructional alloy steel eliminated the need for shipping the forks 75 miles for heat treatment, which was required with the alloy steel previously used.

HOW IT CAN HELP YOU

USS "T-1" Steel, with its high minimum yield strength of 90,000 psi and its minimum tensile strength of 105,000 psi, can help you design or build lighter-weight equipment that will last longer. Its unusual toughness can help you design or build equipment capable of taking severe impact and abuse at sub-zero temperatures. Its excellent weldability can help you cut the cost of fabricating highly stressed parts, and reduce repair and maintenance expense. Its good creep rupture strength can help you put more durability in equipment that operates at temperatures as high as 900 degrees F.

Somewhere in your operation, versatile USS "T-1" Steel can help you. Write, wire, or phone United States Steel, Pittsburgh 30, Pa.

UNITED STATES STEEL CORPORATION, PITTSBURGH • COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO • TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA.
UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS, COAST-TO-COAST • UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS "T-1" CONSTRUCTIONAL ALLOY STEEL

See The United States Steel Hour. It's a full-hour TV program presented every other week by United States Steel. Consult your local newspaper for time and station.

USS

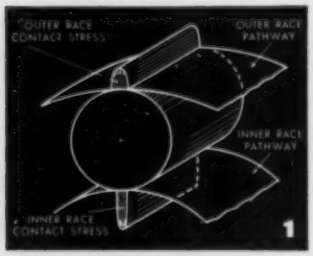
UNITED STATES STEEL

ONE OF A SERIES OF INFORMATIVE MESSAGES FROM HYATT...

Cylindrical Roller Bearing Outer Races

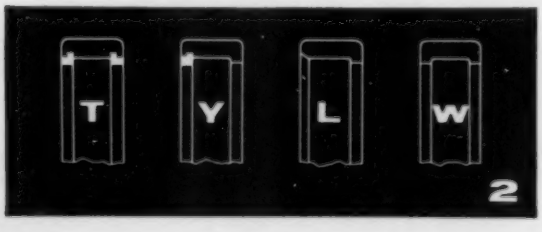
Why they are necessary . . . their importance in relation to bearing versatility . . . wide variety of configurations and locating devices

Outer races are necessary parts of all roller bearings, except in cases where a roller operating surface of suitable hardness and finish can be provided in the housing. In housings of aluminum, cast iron or unheat-treated steel where a hardened and ground surface cannot be obtained by any practical means, outer races are required to assure a fatigue-resistant pathway on which the rollers can operate smoothly.



The outer race is not normally the critical member of a cylindrical roller bearing. This does not mean, however, that outer races cannot suffer fatigue failure. All objects subjected to stress repetitions can fail after a small number of stresses—or may enjoy a surprisingly long life. But experience definitely shows that percentages favor the outer race, and the reason is apparent in Figure 1, which shows a roller engaging both an outer and inner race. Note that the load is spread over a larger area of contact on the outer race, which results in a much smaller maximum stress. This demonstrates in part the principal reason why inner races are the critical member of most cylindrical roller bearings, as explained in one of our previous messages.

Nevertheless, HYATT outer races are manufactured with the same scrupulous care that is applied to inner races and all other components of HYATT Bearings. Outer race performance must match the performance of the rest of the bearing. We consider the fact that the outer race is not the critical member as a safety factor—*not a license to reduce quality.*



1. OUTER RACE TYPES

HYATT Hy-Load outer races are available in a variety of standard configurations for every type of application requirement (Figure 2). The W, L and Y races have solid flanges capable of sustaining light or intermittent thrust loads. The T and Y races are assembled with internal snap rings; they have equal radial load-carrying capacity but are not recommended for applications where a continuous thrust would be taken by the snap rings. The T, Y, L and W races may all be mounted using the roller ends against either the solid shoulder or internal snap ring for purposes of locating the outer race axially.

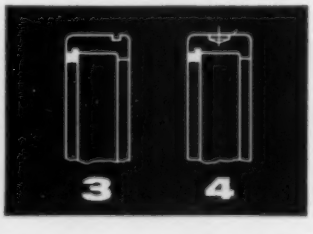
2. CIRCUMFERENTIAL LOCATION

An ample choice of outer race locating methods may be used with HYATT Hy-Loads. Circumferential location is often accomplished by the use of a press fit. (Our general recommendation is that the *rotating* race be applied with a press fit and the *stationary* race be applied with a push fit.) When a push fit is employed, circumferential location is satisfactorily accomplished by axial clamping against the race ends. *Positive* circumferential location is provided by the use of an outer race dowel.

3. AXIAL LOCATION

Axial location of an outer race is conventionally accomplished by pressing or pushing the race to a housing shoulder. The race may be constrained from "walking out" of the housing bore by the flange or snap ring operating against the roller ends. *Positive* axial location is accomplished by axial clamping against a housing shoulder or snap ring.

It may occur, however, that a shoulder is not available in the housing. Under these circumstances, it is necessary to employ an auxiliary holding device such as an external snap ring or an outer race dowel. HYATT Hy-Load Bearings can be supplied to original equipment builders with outer races having a snap ring groove (Figure 3) or a blind dowel hole (Figure 4) at small added cost.



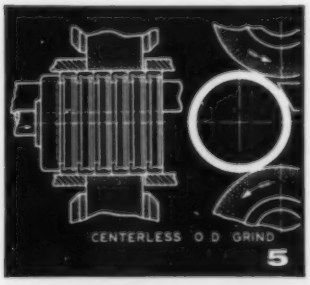
Grinding the flange on a Hyatt outer race.

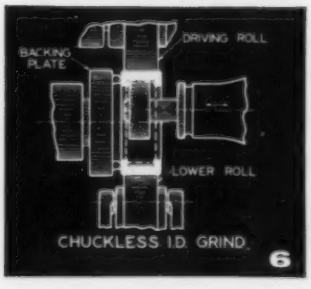
4. OPERATIONAL REQUIREMENTS

Since the outer race is usually the stationary member of the bearing, the exact maintenance of wall variations and runout is not ordinarily critical. However, the outer race *may* be the rotating race in certain applications—so quality controls are rigidly applied to all HYATT outer races to maintain:

a. Minimum wall variation. **b.** Minimum runout of race ends to bore. **c.** Minimum runout of race flange inner faces to bore. **d.** Minimum pathway and outer diameter taper. **e.** Minimum outer diameter tolerance.

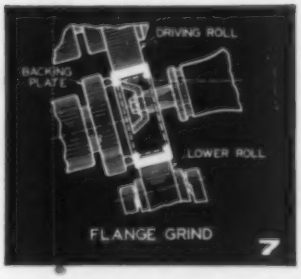
5. MANUFACTURING PROCEDURES





During manufacture, the following sequence of operations provide the controls necessary to generate outer races which meet the strict operational standards maintained by HYATT: After careful primary machining and heat treating, the ends are faced off square and parallel by a double end grind. This provides a reference surface from which all runouts and squareness can be gaged. Outer race diameters are generated by the centerless grinding method to provide an O.D. with as little out-of-round as practical. The through-feed method of grinding represents a valuable economy (Figure 5) to help reduce race costs.

Next, the pathway (or race I.D.) is ground centerless, generating a cylinder concentric with the O.D. cylinder. This is accomplished by driving the race on the O.D. and positioning the grinding wheel relative to the drive roll (Figure 6). Finally, the flanges are ground using the race ends as a reference. The result is a race of as nearly perfect geometry as is practical (Figure 7). It is then critically inspected to insure traditional HYATT dependability and the maximum possible service life.



YOU WILL FIND FURTHER DETAILS in HYATT General Catalog No. 150, or your nearby HYATT Sales Engineer will gladly help you choose the type of cylindrical roller bearings best suited to your design requirements. Remember, HYATT is America's *first* and *foremost* maker of roller bearings. Hyatt Bearings Division of General Motors, Harrison, N. J.

GM GENERAL MOTORS

HYATT

HY-ROLL BEARINGS

FOR MODERN INDUSTRY

DESIGN AROUND THIS NEW

. . . permits motor change in minutes

BOSTON GEAR
100 SERIES
SPEED REDUCERS

Specify the New 100 SERIES

- SIMPLIFY PLANNING
- SAVE TIME
- GET TOP-RATED QUALITY AND PERFORMANCE

OUTPUT RATINGS *Certified* by INDEPENDENT LABORATORY tests

PATENTS PENDING

BOSTON Gear
100 SERIES
REDUCTORS

- NEW space saving design
- NEW clean contours
- NEW gearing efficiency
- NEW cooling fins
- FAN COOLING optional on larger sizes

COST-SAVING "COMBINATION"

. . . continued operation with spare

No downtime for motor repairs!

The new 100 SERIES RATIOMOTOR combines an independent gear reduction unit and an easily detachable standard end-mounted motor.

MOTOR CAN BE REMOVED AND REPLACED in a few minutes, without disturbing the gear reduction unit. Saves maintenance time, preserves alignment, permits continued operation with spare motor.

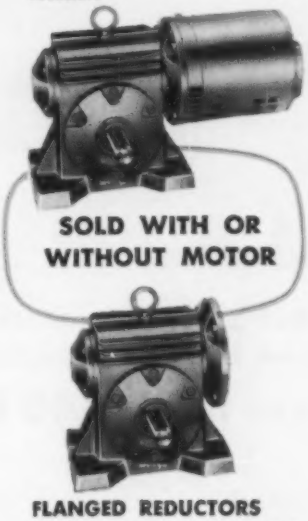
ORIGINAL MOTOR CAN BE CHANGED When conditions require change to a motor of special characteristics (totally enclosed, explosion-proof, etc.) it can easily be attached in place of the original motor.

ANY MODEL YOU NEED — FROM STOCK The new BOSTON GEAR 100 SERIES includes 1605 different units to fit any drive need. Reductors, for mechanical drives, as well as Ratiomotors and Flanged Reductors, are *standardized stock units* sold by BOSTON GEAR Distributors, located in every industrial center of the U. S. and Canada.

TALK TO A BOSTON GEAR FIELD ENGINEER Our 76-year experience as speed reducer specialists will help you simplify planning, and put your product ahead in design. Your Boston Gear Distributor will arrange a call, or write: Boston Gear Works, 71 Hayward St., Quincy 71, Mass.

RATIOMOTORS

The complete power package. Gear unit has fin-cooling and other high efficiency features of new 100 Series Reductors.



FLANGED REDUCTORS

The Ratiomotor gear unit, supplied without motor. You buy and attach any standard end-mounted motor of your own choice.

1605 DIFFERENT TYPES AND RATIOS — FROM STOCK

Call your **BOSTON** *Gear* **DISTRIBUTOR**

For nearest Distributor, look under "GEARS" in the Yellow Section of your Telephone Directory.

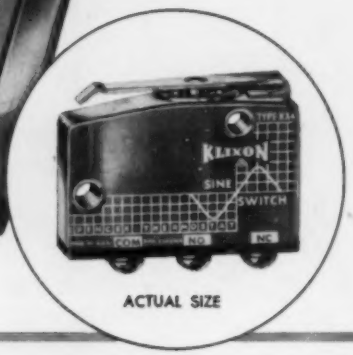
GET NEW CATALOG No. 56

Lists all models of Reductors and Ratiomotors — horizontal or vertical — right angle or parallel — single or double reduction. Includes handy selection charts, engineering data.
Also lists complete information on the full line of 7124 standardized transmission products from stock, for off-the-shelf delivery by your local BOSTON GEAR Distributor.

108 MODELS — 1064 DIFFERENT UNITS — FROM STOCK

56-BG-R-17

3X cut-away view of KLIXON KX4 Sine Switch



ACTUAL SIZE

Get precision switching completely free from environmental conditions

...with the KLIXON KX4 Sine Switch

Here's a small precision switch especially designed for use in aircraft and guided missiles, jet engine speed and fuel controls, signalling devices and precision instrumentation, chemical and packaging machinery, and industrial equipment.

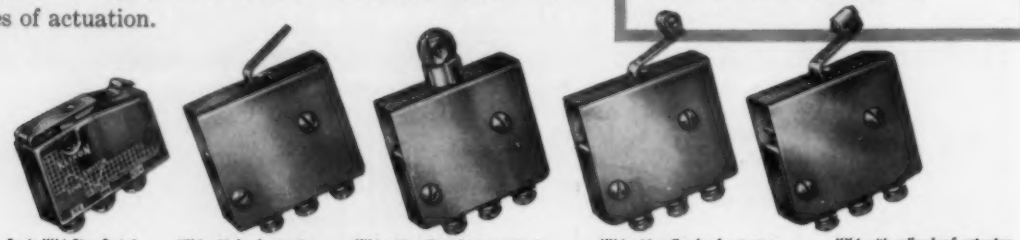
KLIXON KX4 Sine Switches are sealed in an extra strong steel case designed to withstand heavy impact and compression loads. True hermetic sealing is achieved with a metal "wave type" diaphragm at the actuating lever.

The KLIXON KX4 Sine Switch has maximum clearances between current carrying parts. It can be ganged easily for multiple pole operation and is adaptable to many types of actuation.

Other features of the KX4 include:

- **HIGH CURRENT CAPACITY** . . . unique design of Sine Blade eliminates knife edges . . . provides double current path through blade . . . gives efficient heat dissipation and long electrical life.
- **HIGH SHOCK AND VIBRATION RESISTANCE** . . . precise operations unaffected by shock as high as 200 g's . . . vibration of 40 g's, 0-500 cps.
- **WIDE AMBIENT TEMPERATURE RANGE** . . . continuous operation at temperatures as high as 200°F . . . precise operation unaffected under rapid cycling from −65°F to +200°F within five minutes.
- **STANDARD SIZE** . . . meets mounting requirements of Military Standard AN3234.

Technical Data Sheets on the KX4 and other KLIXON Sine Switches now in production are available. Write for Bulletins PRSW-2, 3, 4 and 5.

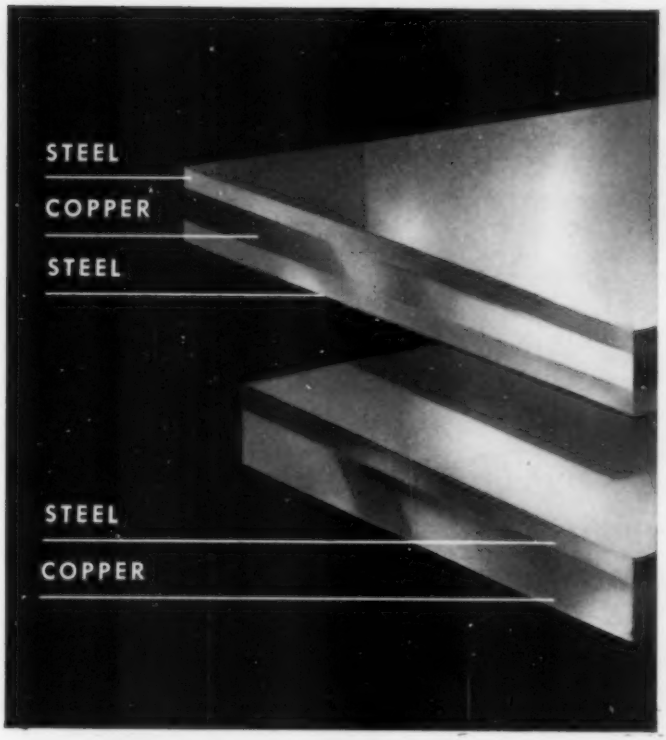


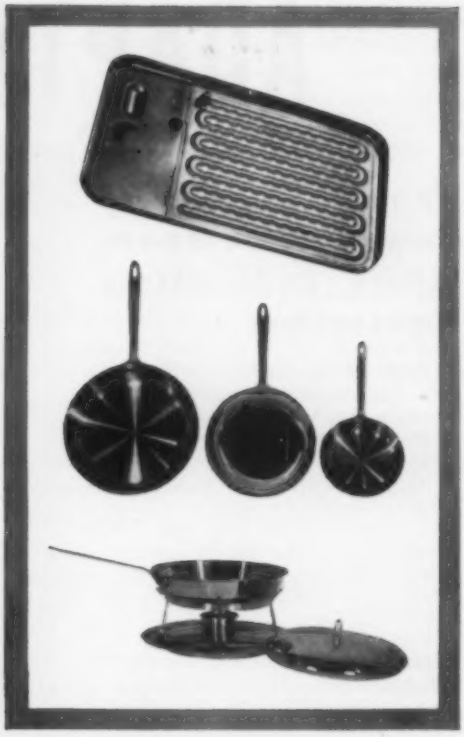
Basic KX4 Sine Switch | KX4 with leaf actuator | KX4 with roller-plunger actuator | KX4 with roller-leaf actuator | KX4 with roller-leaf actuator

METALS & CONTROLS CORPORATION
SPENCER THERMOSTAT DIVISION
3812 FOREST STREET, ATTLEBORO, MASS., U. S. A.

KLIXON®

Two Metals
are often Better than one!





...and GENERAL PLATE Stainless Clad Copper is a case in point

Here's what General Plate Stainless Clad Copper offers:

- **High thermal and electrical conductivity for excellent heat transfer**
- **Corrosion resistance equal to stainless steel**
- **Superior performance at elevated temperatures**

You can profit by using General Plate Clad Metals

General Plate's Stainless Clad Copper strip adds the superior thermal conductivity of copper to the high temperature corrosion resistance of stainless steel. Molecularly bonded without brazing alloys or other intermediate agents, these two metals combine in clad form to offer improved characteristics for a wide range of applications involving electrical conductivity or heat exchange.

If you are interested in metals with new and better characteristics — look to General Plate Clad Metals. Write today without obligation for new catalog, PR-700A, describing many clad metal combinations — both precious and base metal; TRUFLEX® Thermostat Metals; composite electrical contact buttons and rivets.

METALS & CONTROLS CORPORATION
GENERAL PLATE DIVISION
1012 FOREST STREET, ATTLEBORO, MASS.

NEW CONTROLLER LINE ADAPTS 576 WAYS

Fenwal Announces Low-Cost Temperature Indicating Controllers

ASHLAND, MASS. — Fenwal Inc., has announced here that tailor-made, accurate, low-cost temperature indicating controllers are now available from stock.

Tailor-mades from stock are made possible by the development of the new Fenwal Series 541 line. The Series 541 is a standardized line of matched temperature indicating controller parts which can be combined easily in 576 ways.

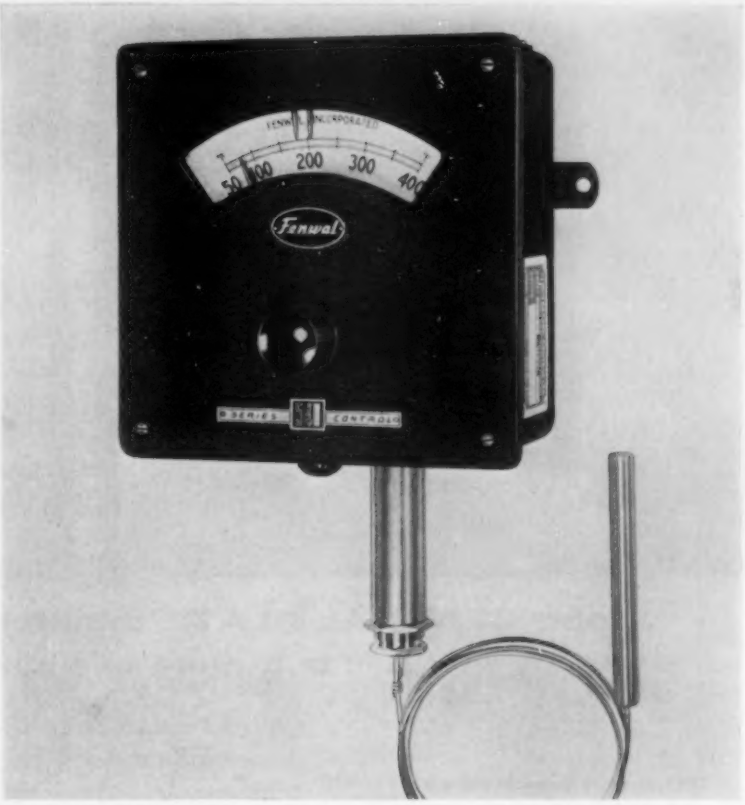
From these possible combinations come perfect solutions to countless temperature control problems. A prospective user lists the characteristics of the ideal temperature indicating controller for his particular operation, and Fenwal assembles an instrument with those characteristics from parts in stock.

No matter what combination is chosen, the result is a rugged, accurate, compact and easily maintained unit in a shock-proof, splash-proof, dust-proof housing. The housing is available in colors to match any equipment in which it may be installed.

Installation and calibration are so simple that instrument technicians and laboratory procedures are unnecessary. And, after installation, all normal temperature adjustments are external.

No matter what combination is chosen, the resulting instrument is accurate to within one per cent of scale. The accuracy is long lasting, with few moving parts and no internal gears. Simplicity of design brings the wear factor close to zero.

Series 541 offers single or double circuit control. There is a choice of four different long-life snap switches, with ratings up to 20 amps, 250 volts, A.C. These switches, singly or in combination, can provide a wide variety of operating characteristics.



One of Fenwal's new Series 541, bulb-and-capillary controllers. Photo shows dual circuit model which has two snap switches, each with a setpoint indicator, that actuate two separate circuits at the pre-set temperatures.

Three stainless steel bulb types are available at no increase in price to meet space or process requirements. Capillaries and bulbs are corrosion-proof. Capillaries are swivel-mounted to protect them from breakage.

There is a choice of three temperature ranges: −150° to 200°F, 50° to 400°F, or 50° to 700°F, or their centigrade equivalents. Special ranges are available on request.

The control mechanism may be subjected to temperatures up to 150°F, and is ambient compensated from 50° to 150°F.

Write to Fenwal Incorporated, 212 Pleasant Street, Ashland, Mass. Describe the tailor-made temperature indicating controller that would fit your operation perfectly. Chances are excellent that the tailor-made can be yours — at savings never before possible.

Fenwal

CONTROLS TEMPERATURE ... *PRECISELY*

ALCOA'S UP-TO-DATER ON CASTINGS

Four new-development pages on super-strength impellers, uniform-wall castings, unusual permanent-mold castings, new high-strength alloys, and other meaty data for today's smart young men who will be supervisors tomorrow.

meaty data for today's smart young men

"Close Tolerances"—a Misnomer?

Precision, or close tolerance, casting saves a bundle on jobs that used to require much expensive machining. "Close tolerances" and "smooth finishes" are loosely used phrases. They mean anything tighter than the old sand foundry standard of ± 1/32″ and 500 micro-inches.

At Alcoa, by using plaster-mold processes, tolerances of 0.005″ are possible on certain jobs. Pattern smoothness and close tolerances are easily reproduced since the mold starts as a slurry of gypsum. And plaster molding is often combined with sand-and-iron molding to produce amazing castings.

Plaster molding, and its ability to be combined with other methods, add a new tool to the designer's toolbox. We'd like to explore the possibilities with you.

Sand casting, however, is still far from over the hill. It still is the cheapest method for a short run and certainly a widely used process at Alcoa. Occasionally, on certain small items we use match plate techniques and high-speed molding machines to knock them out faster and cheaper in sand than we can do in die castings or permanent-mold castings. Our sand castings run from a few ounces all the way up to a diesel engine cylinder block, 9′ x 6′ x 6′, weighing 7450 pounds.

Most Uniform Walls Ever Cast

Plaster castings with wall thicknesses down to .060″ are now being made at Alcoa. Tolerances are ± .005″ wall thickness. Right now, they're air scoops for the aircraft industry, made in both rounds and rectangles up to about 25″ long. Curved shapes present no problems. The process is more expensive but worth it because it cuts the weight of an air scoop in half. If your problem is thin, uniform walls, we'd like to explore the possibilities with you.

hopped on the new alloy band wagon to replace expensively machined and fabricated wrought parts

What Is a "Large Permanent-Mold Casting"?

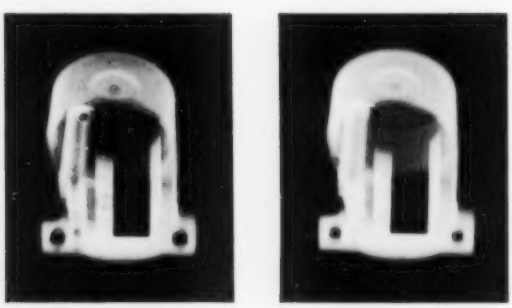
Not so long ago, permanent-mold castings larger than 12 inches and 2 or 3 pounds were rare as dodoes. Now we cast a cylinder of 800 pounds, 36 inches high, 30 inches diameter with 4-inch walls in permanent molds. The part is a rolling mill bearing. Others include engine pistons of 250 pounds, compressor cases for jets of 150 pounds.

We're now casting the entire bumper of a 1957 automobile . . . a routine permanent-mold job. These 28-pound castings are not only large but also are made in large quantities.

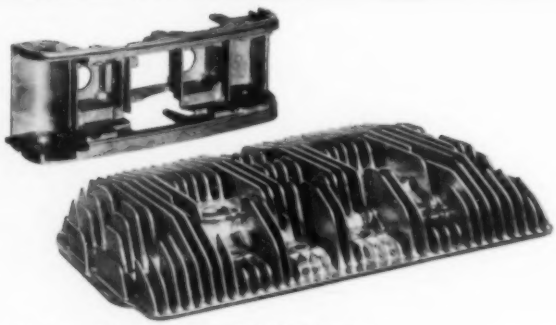
More than one designer has made himself a hero to his boss by looking into permanent-mold castings. Smooth and clean surfaces, medium-to-long production runs, tolerances of 1/64" plus .002" per inch (although 1/32" in 5 feet has been made), good mechanical properties and modest complexity usually indicate permanent-mold castings.

Super-Strength and High-Speed Impellers

Imagine an impeller, 9½" diameter, spinning at 60,000 rpm. Peripheral tip-speed tops 2500 ft. per second, 1800 mph. That's a casting recently turned out by a radical new manufacturing technique. Another impeller, to operate at 58,000 rpm, has delicate curved blades with the as-cast leading edges tapering to .020". These two examples are used for turbo-charging and weigh 3 or 4 pounds. Other super-strength impellers for industrial refrigeration weigh 400 lbs. This new process gives properties as high as 50,000 psi tensile, 35,000 psi yield, 5% elongation.



High-Density Process — At left, X-ray photo of casting made by conventional die-casting method. At right, X-ray print of same part cast by Alcoa's new high-density process — porosity virtually eliminated.



Complex Die Casting — Cylinder head and camera frame are interesting examples of modern Alcoa Die Castings.

Cost-reduction note: The super-strength process can be combined with ordinary *cast* properties in the same part and at substantial savings.

Die Castings—Greater Use and Growing Size

Just a few years ago, aluminum die castings were used mostly as shrouds or covers. Now they're used for many structural parts. Reason: As labor rates have gone up, so has the use of die castings —to save assembly and machining costs. New alloys have given aluminum die castings greater strength and ductility: For air-conditioning compressor parts, automotive transmissions, vacuum cleaners, cylinder heads, etc. Alloys with high endurance limits are responsible for the increasing use of die castings in highly stressed reciprocating parts. As to size, office chair swivel bases and rotary lawn mower enclosures are now being die-cast at Alcoa.

high-density method for small, chunky parts

Alcoa has developed a high-density casting method for small chunky parts. Now soundness approximating wrought materials is possible as examination of the accompanying X-ray photos shows.

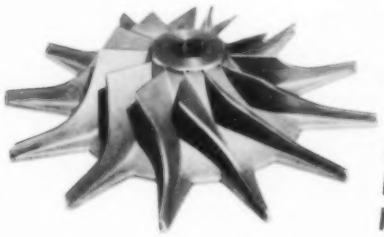
Need High-Strength Alloys? Here Are Three New Problem Solvers

Perhaps the toughest nut to crack in designing an aluminum casting is to pick the right alloy. That is, if you go it alone. Alcoa has over 40 standard casting alloys and each one is designed for a specific use. Your Alcoa representative is an authority on alloys. Use him.

Several of the most recent alloys are worthy of special note: Two are alloys C355 and A356 *for permanent-mold work*. Being high-purity variations of the familiar 355 and 356, they require careful foundry handling but develop extremely high levels of strength and ductility. Shown, on the next page, are the properties for permanent-mold cast test bars for these new alloys in two tempers.

more than one designer has made himself a hero to his boss with permanent-mold castings

Super-Strength Impeller — Diesel engine turbocharger impeller spins at 58,000 rpm. Edges taper to air cleaving .020". Plaster-casting process.



Large Permanent-Mold Casting — Rolling mill bearing goes 800 lbs., 3 ft. high, 2½ ft. diameter, 4 in. walls.

Uniform Walls — Plaster-cast air scoop includes walls with thicknesses of .060", with wall tolerances of .005".

Mechanical Properties

In the die-casting field, alloy X364 is going to increase applications where strength in highly stressed parts is important. Its properties are roughly equal to those of alloy 218, but it's easier to cast and therefore cheaper. Its price will be slightly higher than 380 and 360 alloys so it shouldn't be specified as a replacement for those alloys unless higher strength, better elongation and impact resistance are needed. Shown is a chart giving typical properties (obtained with die-cast ¼" test bars) of this experimental alloy X364, as compared with 218, 360 and 380 alloys.

	Guaranteed Minimum			Typical		
Alloy & Temper	Tensile psi	Yield psi	Elong. %	Tensile psi	Yield psi	Elong. psi
C355-T61	40,000	30,000	3.0	46,000	34,000	6.0
C355-T62	47,000	40,000	1.5	52,000	44,000	4.0
A356-T6	32,000	18,000	10.5	37,000	22,000	15.0
A356-T61	37,000	26,000	5.0	41,000	30,000	10.0

Alloy	Temper	Tensile Strength-psi	Yield Strength-psi	Elongation %
X364	—F	41,000	22,000	7.5
X364	—T5	46,000	33,000	4.0
218	—F	45,000	27,000	8.0
360	—F	44,000	27,000	3.0
380	—F	43,000	26,000	2.0

Right now the ones who have hopped on the C355, X364 and A356 alloy band wagon are designers who are using these alloys to replace wrought structures which involved expensive machining and fabrication. But we expect real interest from designers faced with any part subject to impact. Stir up any ideas?

when a designer needs three eyes: for costs, competition and performance

Straight Talk

In these days, when a designer needs three eyes, one for costs, one for competition and one for performance, he has often found the answer to all three problems in Alcoa® Castings. Many times, the solid technical help contributed by the Alcoa sales engineers and casting specialists has either cut costs or improved performance. And, *because Alcoa offers all casting processes their recommendations are completely unbiased.*

The nicest thing about this help is that it's free and waiting at your local Alcoa office, listed under "Aluminum" in your classified phone book. Better yet, write for your copy of Alcoa's new technical book, *Alcoa Aluminum Handbook*, 176 pages, 140 tables. ALUMINUM COMPANY OF AMERICA, 1994-M Alcoa Building, Pittsburgh 19, Pennsylvania.

Your Guide to the Best in Aluminum Value

ALCOA ALUMINUM CASTINGS

Litho in U.S.A.

FROM BRUNING – Your One Convenient Source for All Drafting Needs...

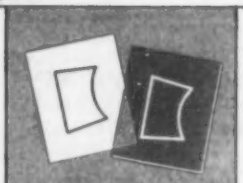
5 "Thrifty Nifties"

That Will Save You Time, Work, and Money!

Little things mean a lot in drafting! That's why the five outstanding, low-cost drafting aids featured here are important to you. That's why they and many products like them are important members of Bruning's complete quality line. Try them; you'll be mighty pleased at how fast the savings of time and labor mount up!

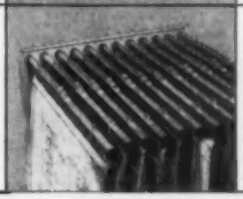
BRUNING ELECTRIC ERASING MACHINE
Save hours of finger-cramping manual erasing. Do a neater, safer erasing job. The patented hollow shaft permits use of extra-long, seven-inch eraser, prevents "fly-outs". These quiet, cool, vibration-free tools are permanently lubricated, require no maintenance.

"RULE-O-MATIC" RULING PEN
Just a press of the finger, and a drop of ink flows into the stainless steel nibs from a replaceable cartridge in the hollow handle. One cartridge containing government approved India ink can rule up to 55,000 inches. Lifetime guarantee. Costs no more than any quality ruling pen of conventional design.



"SURE-SCALE" FILMS
New Bruning Sure-Scale Films are made of MYLAR*, the most dimensionally stable, strongest, most durable of all drawing and scribing films. Because they are flexible, light, readily filable and mailable, they lend themselves beautifully to the making of precision templates. They offer excellent working qualities.
*DuPont's trade mark for its polyester film.

"MOBILE" PARALLEL STRAIGHTEDGE
It rolls freely and smoothly over your drawing on retractile rollers located on the underside of the blade—lets you make neater drawings, faster and easier! Rollers retract under slight pressure, won't damage your drawing. Easy rolling action permits fingertip positioning of the edge, eliminates smudging.



"PLAN HOLD" VERTICAL FILES
Save time, space, and print damage in filing large, active plans and prints. Strong, spring-loaded, clamp-style binders eliminate punching, stapling, bolting, or folding of prints. Binders slide into brackets which are mounted on wall racks, floor stands, or in cabinets. Each binder holds up to 150 prints, is easily detached for access to prints.

Take a minute now to mail the coupon. Save yourself hours of time and work later on.

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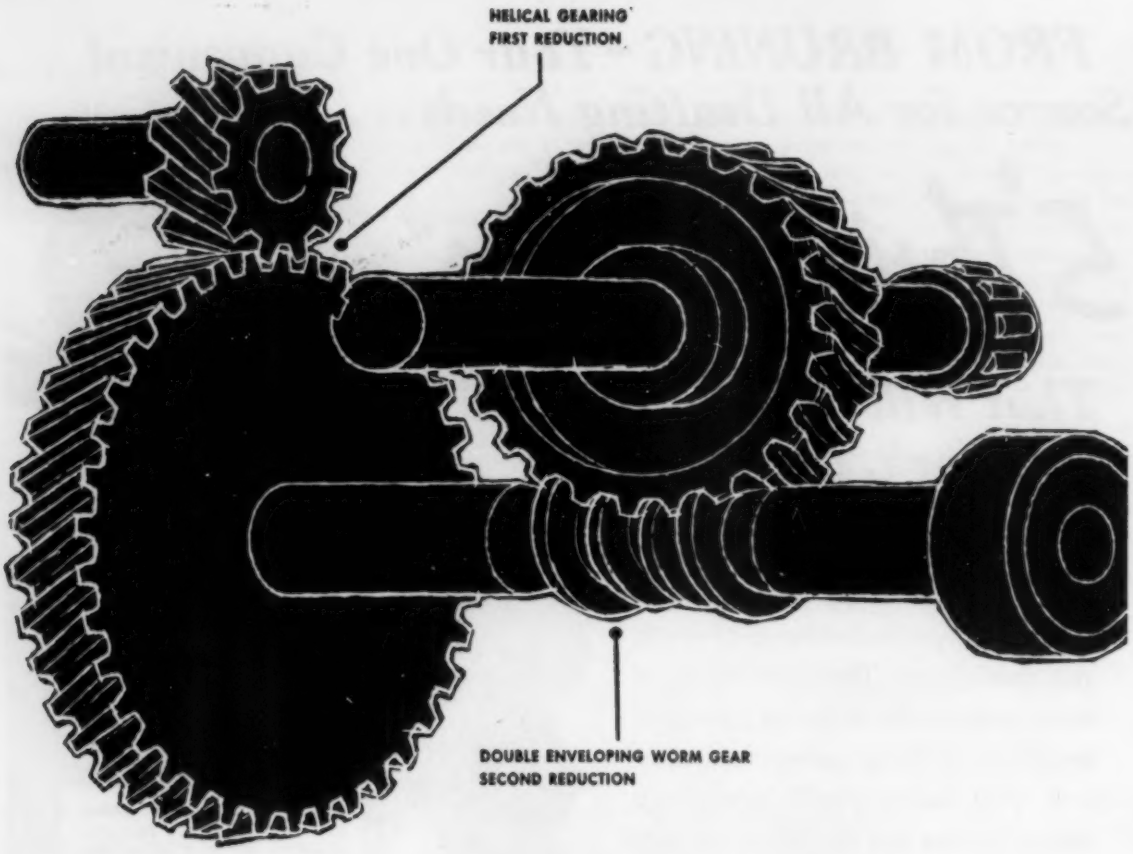


How Westinghouse new right-angle gearmotor delivers 32% more power

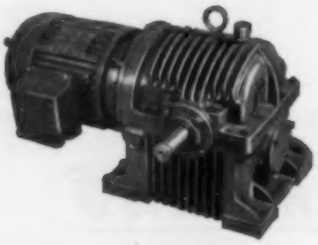
With this exclusive match of gearing, Westinghouse right-angle gearmotor gives you top horsepower and rugged dependability at the lowest cost. It's the result of skillful use of helical gearing to gain maximum efficiency from high lead-angle worm gearing. Over a range of speed reduction, from 20:1 to over 100:1, the Westinghouse right-angle gearmotor *averages* 32% more power than conventional single-reduction, worm gearmotors. At a ratio of 60:1 you actually get 98% more power.

Greater dependability and long life result from Westinghouse exclusive double-enveloping worm gear. It provides 330% more gear-tooth area to support the load. As wear occurs, only double-enveloping gears regenerate or reproduce themselves.

In application, Westinghouse design for high overhung load capacity requires no outboard support. Right-angle gearmotors are available in a complete range of AGMA output speeds and Life-Line® "A" motor enclosures.

FREE detailed facts about Westinghouse new right-angle gearmotor in booklet B-6579. Call your local Westinghouse Sales Office or write Westinghouse Electric Corporation, 3 Gateway Center, P. O. Box 868, Pittsburgh 30, Pa.

J-07349-A



WATCH WESTINGHOUSE!

*WHERE **BIG** THINGS ARE HAPPENING **TODAY!***

9 design problems that can be met with the... Allenut

Ever-increasing applications for the new ALLENUT have caused sales to double within the past two years. Here are some of the things it can do to aid your product designing:

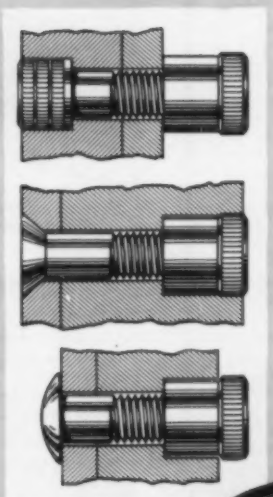
1. Self-anchoring in any metal. Allenut provides positive anchoring action through its hardened knurls.

2. Compact design. Requires no space for box wrenching. 12-point socket permits tightening in awkward places.

3. Smooth surfaces. Fits flush or below surface in counterbored hole . . . permits streamlined, safe surfaces.

4. A ready-made, hardened, tapped hole. When used as a bushing, prevents costly stripping of threads caused by frequent removal and replacement of screw or bolt. In castings and other soft metals a stripped hole can be counterbored, an Allenut inserted and the same bolt or screw used.

5. Tighter fit. Greater thread contact than with ordinary nuts because of Class 3 fit. Weld-like setups accomplished with one hand wrenching. Allenut holds firm against turn of screw.



6. Usable with any type of bolt or screw. Permits space-saving, internal wrenching of cap screws, T bolts, machine bolts, and other common fasteners.

7. Saves parts. No washers required when anchored.

8. Easier to use. Knurled ring facilitates fingering-in. Allenut is always square to counterbored hole. Removable by hitting screw or bolt head with tap of a hammer.

9. Reusable indefinitely. Anchoring action remains unimpaired. Hardened threads and socket stand up under repeated removal and replacement.

Allenuts are available in a full range of 14 standard sizes from no. 4 to 1" from leading industrial distributors.

We welcome your inquiry and request for engineering details on Allenut applications.

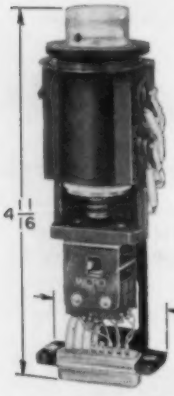
MICRO precision switches

...THEIR USE IS A PRINCIPLE OF GOOD DESIGN

there is always "SOMETHING NEW" at MICRO SWITCH for product designers

Experienced designers know both time and money are saved when they check with MICRO SWITCH on their complex switching problems. If we have not already solved their problem, MICRO SWITCH engineering is experienced in cooperating with product designers to quickly develop a precision switch to meet the requirements.

Here are four such new switches, each developed to meet a specific need, each capable of many variations of actuation, circuitry and housings.



"PB" Series 3-light pushbutton actuated switch

3-LIGHT PUSHBUTTON SWITCH FOR COMPLEX CONTROL PANELS

Here is a new, unique indicating pushbutton switch which lights in three different colors. This compact assembly is the result of an original requirement for a "super-reliable" long-life pushbutton switch for use in computer consoles for guided missiles control systems.

Designed for use in applications where *absolute dependability* is required, this switch is manufactured under extremely careful quality control procedures. The result is a reliable life through hundreds of thousands of operations.

A special, exclusive feature is the incorporation of a "radio tube" type connector, or plug-in base, which carries all the connections to the basic switches and lamp terminals. The entire assembly is easily pulled out for lamp replacement. (*Send for Data Sheet 110*)

Three-position rotary type toggle switch. "TR" Series

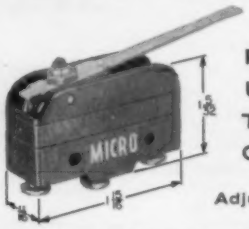
THIS TOGGLE SWITCH HAS LONG LIFE AND BETTER DETENT "FEEL"

Here is a new solution to the problem of mechanical actuation of many circuits with a single manual motion. This new series of "TR" switches offers all the advantages of a toggle switch mechanism plus *longer operating life and better detent "feel."*

These switches provide a high electrical capacity in a very small space, permitting the elimination of relays and other electrical devices in many circuits.

They are rugged enough for most airborne and industrial applications and have successfully passed rigid tests for impact, shock, acceleration and vibration.

The "TR" switch shown is a four-pole double-throw switch with 12 terminals. It is maintained in all three actuation positions: on-off-on. Other "TR" switches are available with up to 24 terminals (8 poles). (*Send for Data Sheet 112*)



Adjustable lever actuated switch

PRECISE, UNERRING ACTUATION THROUGH MILLIONS OF OPERATIONS

An adjustable lever actuator on this switch permits close adjustment of the operating point without removing the switch from its mounting.

This switch is designed for use on such equipment as timers, computers or other multiple-mounted switch devices which require *precise, unerring actuation* through *millions of operations.*

The operating position is adjustable through .210 inch. The switches are available with a wide selection of pre-set operating characteristics. They are also available with split-contact double-throw circuitry. (*Send for Data Sheet 100*)

THIS SWITCH GIVES PRECISE PERFORMANCE UNDER MOST EXTREME CONDITIONS

The MICRO "EN" Switch is completely sealed, cylindrical in shape. Tests have shown its precise performance to be unaffected by ice-coating at −65°F or by heat to +180°F. A thousand hours in salt brine spray or 30 days operation at 104°F (95% humidity) still finds it going strong—and precisely. No chattering of contacts, no loosening of parts occurs during vibration tests of 10 to 500 cycles per second.

Contact arrangement is double-pole, double-throw. Weight (without leads) 2½ oz.

(*Send for Data Sheet No. 105*)

MICRO SWITCH *Engineering is at your service from convenient branch offices in key cities everywhere. It is as close as your telephone. Consultation costs you nothing. Can save you time and money.*

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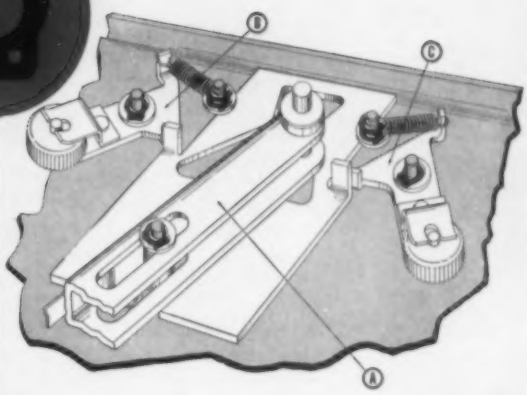
Waldes Truarc grip rings used on die-cast studs eliminate threading, tapping, other costly machining

Mark Simpson Manufacturing Co., Long Island City, N. Y., uses Waldes Truarc series 5555 Grip Rings to secure parts to studs of the zinc die-cast base of its "Masco 500" portable tape recorder.
The rings—which need no grooves—replace nuts, screws, cotter pins and other types of fastening devices which require threading, tapping, drilling and other expensive machining operations. Because a single cracked or broken stud would render the entire cast base useless—and with it, all assembly completed to that point—the rings also eliminate extremely costly rejects.



Pivot Assembly of shift lever (A) is secured by a single Waldes Truarc Grip Ring and washer. Because the washer must be installed over the shift level in a sliding fit, critical tolerances would have to be maintained if a screw or cotter pin were used. The Truarc Grip Ring eliminates that problem: it requires no groove and may be seated over the washer at any point on the stud, automatically compensating for accumulated tolerances in the parts. BRAKE ASSEMBLIES (B and C) use Grip Rings to secure the brake wheel and spring subassemblies. Here again problems of critical tolerances are avoided and expensive rejects eliminated.

Whatever you make, there's a Waldes Truarc Retaining Ring designed to improve your product... to save you material, machining and labor costs. They're quick and easy to assemble and disassemble, and they do a better job of holding parts together. Truarc rings are precision engineered and precision made, quality controlled from raw material to finished ring.

36 functionally different types... as many as 97 different sizes within a type... 5 metal specifications and 14 different finishes. Truarc rings are available from 90 stocking points throughout the U. S. A. and Canada.

More than 30 engineering-minded factory representatives and 700 field men are available to you on call. Send us your blueprints today... let our Truarc engineers help you solve design, assembly and production problems... without obligation.

For precision internal grooving and undercutting... Waldes Truarc Grooving Tool!

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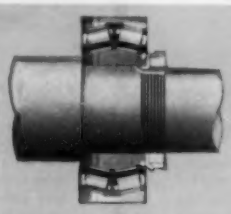
WALDES TRUARC Retaining Rings, Grooving Tools, Pliers, Applicators and Dispensers are protected by one or more of the following U. S. Patents: 2,382,948; 2,411,426; 2,411,761; 2,416,852; 2,420,921; 2,428,341; 2,439,785; 2,441,846; 2,455,165; 2,483,379; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,306; 2,491,310; 2,509,081; 2,544,631; 2,546,616; 2,547,263; 2,558,704; 2,574,034; 2,577,319; 2,595,787, and other U. S. Patents pending. Equal patent protection established in foreign countries.

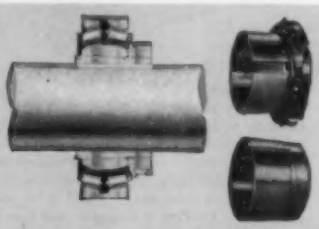
MORE FACTS on why more and more leading manufacturers choose Link-Belt bearings

ALLIS-CHALMERS MOTOR GRADER capitalizes on the ability of Link-Belt self-aligning roller bearings to handle high shock loads.

FREE-ROLLING — SELF-ALIGNING. Spherical inner ring is free to align in any direction. Load is distributed over entire roller assuring full load capacity. Destructive edge loading cannot occur.



DIRECT SHAFT MOUNTING with bearing being pressed or shrunk on the shaft. Especially desirable to achieve maximum economy on production applications.



ADAPTER MOUNTING permits use of commercial shafting without machining. Easy installation and removal of adapter-type bearings are provided by the tapered sleeve, locknut and lockwasher.

Builders of industry's heaviest equipment

choose this self-aligning roller bearing for toughest applications

You're in company with blue-chip machinery makers when you specify high-capacity Link-Belt self-aligning roller bearings. Wherever tough-duty equipment calls for self-contained, pre-adjusted bearings and simple mounting, you'll find them on the job . . . handling heavy radial and thrust shock loads.

These self-aligning roller bearings have internationally standardized boundary dimensions and are available everywhere. Link-Belt also makes industry's most complete line of ball and roller bearing blocks. This includes pillow blocks plus flange, flange cartridge, cartridge, take-up and hanger blocks. Ask any one of the 40 Link-Belt offices for data Book 2550.

LINK-BELT

Ball and Roller Bearings 13,903-A

Bearing boundary dimensions are international standards for Series 22200 and 22300—22500-A and 22600-A.

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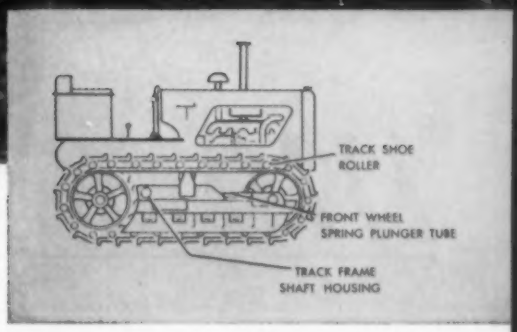

For top performance and long service

this rugged Tractor relies on machine parts of

SHELBY SEAMLESS TUBING

In this powerful Oliver OC-12 Bulldozer, the following parts are fabricated from Shelby Seamless Mechanical Tubing – track shoe rollers, front wheel spring plunger tubes, and the track frame shaft housing. The chief qualifications possessed by these parts are high strength and superior wearability . . . qualities that are just right for a heavy-duty tractor application.

Super-rugged equipment calls for super-strong materials. That's why you'll find USS Shelby Seamless Mechanical Tubing being used for so many tractor applications. Its great strength, complete uniformity, and extreme dimensional accuracy make Shelby Seamless the ideal mechanical tubing for the fabrication of machine parts subject to bruising performance and long wear.

Available in a wide range of diameters, wall thicknesses, various shapes and steel analyses, Shelby Seamless Mechanical Tubing is produced to exacting standards by the world's largest manufacturer of tubular steel products. Contact our engineers for recommendations. They will welcome the opportunity to help you apply Shelby Seamless to your specifications.

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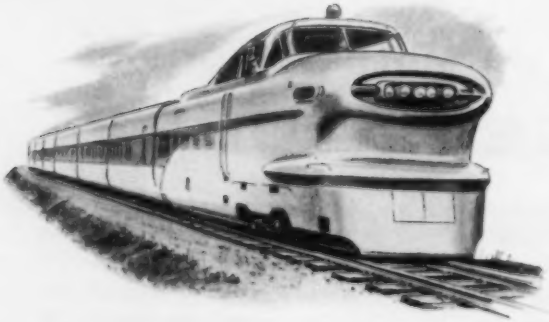
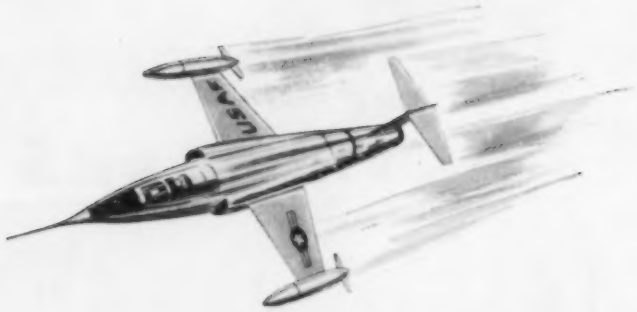
USS **SHELBY SEAMLESS MECHANICAL TUBING**

UNITED STATES STEEL

Now... You can make more things of





Stainless Steel

The new "200" Series Stainless Steels successfully ease nickel shortage!

With the new low-nickel "200" Series Stainless Steels, producers can greatly expand their output of Chrome-Nickel stainless from existing nickel supplies. These steels provide practical, workable grades of stainless that can be applied to a wide variety of uses.

Made of Chromium-Nickel-Manganese—the "200" Series steels are helping to meet constantly growing needs in transportation, building, manufacturing and many other fields. They're becoming increasingly popular in kitchen utensils, appliances, truck bodies, trains, automobile trim, and scores of products for industrial, home and business use. For further information, see your stainless steel supplier, or write Electromet—leading producer of more than 100 alloys, including chromium and manganese, for the steel and non-ferrous metal industries.

ELECTRO METALLURGICAL COMPANY

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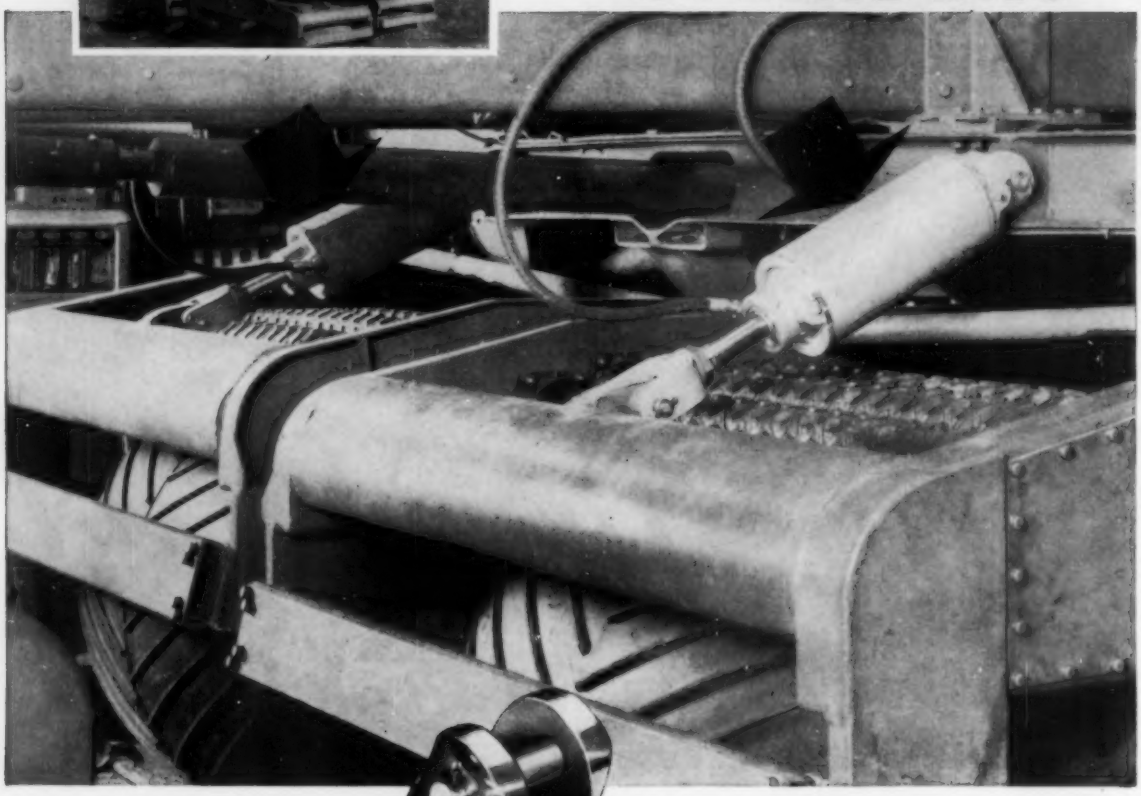
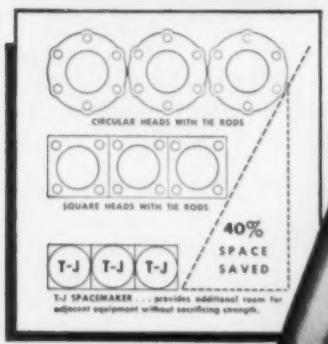
Arctic Cargo Carrier Depends On T-J Spacemaker CYLINDERS




CIRCULAR HEADS WITH TIE RODS
SQUARE HEADS WITH TIE RODS
40% SPACE SAVED
T-J
T-J
T-J
T-J SPACEMAKER . . . provides additional room for adjacent equipment without sacrificing strength.

ALL MODELS . . . OFF SHELF DELIVERY

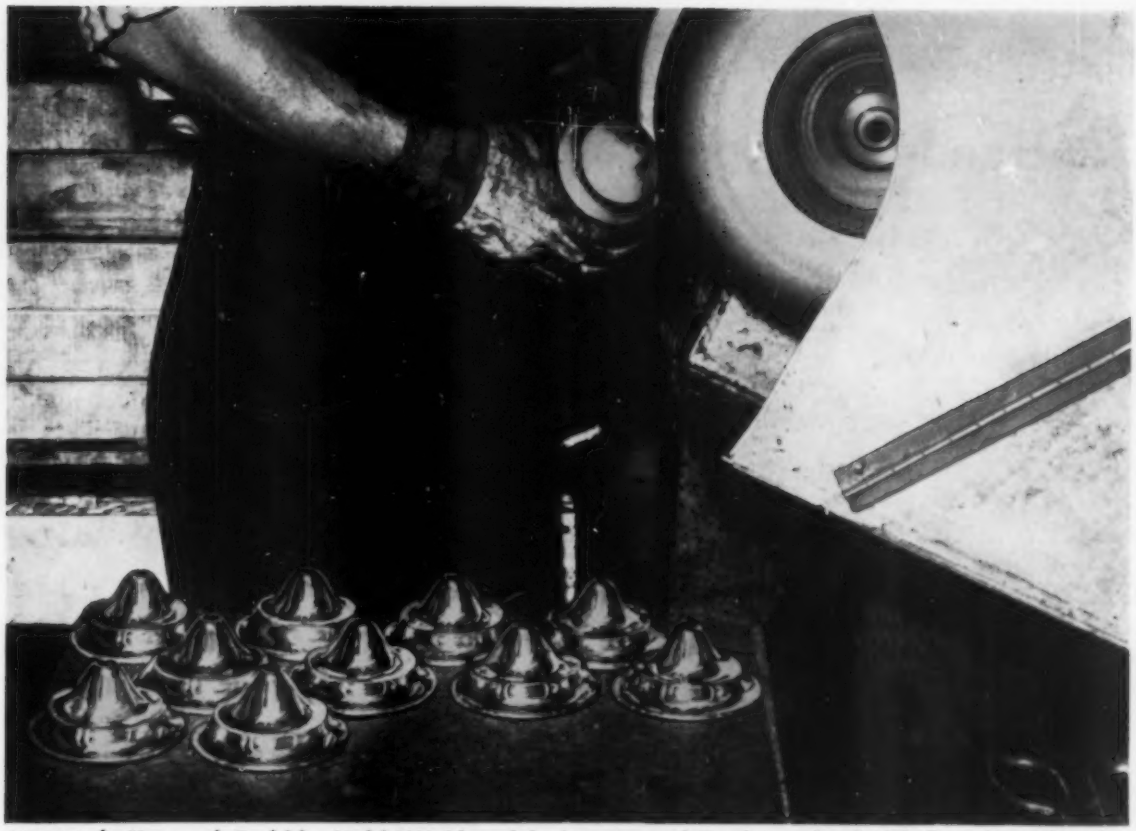
MEETS WITH ALL JIC RECOMMENDATIONS

Saves 40% Space!
No Tie Rods For Greater Strength

Differential axle loading through T-J Spacemaker Air Cylinders forms a controlled walking beam in this Teracruiser, designed and produced for the Army Ordnance Corps by the Four Wheel Drive Co., Clintonville, Wis.

Weight of cylinders was important factor in choosing T-J Spacemakers, which reduce weight while providing same displacement and extra high safety factor. Fast delivery and space-saving features also favored T-J. Exclusive with T-J are new Super Cushion Flexible Seals for Air (to 200 P.S.I.) . . . and New Self-Aligning Master Cushion for Oil (to 750 P.S.I.). Hard chrome plated bodies and piston rods are standard, at no extra cost. Wide range of styles, capacities . . . 64,000 combinations *off the shelf!* Write for bulletin SM-155-3. The Tomkins-Johnson Co., Jackson, Mich.

T-J TOMKINS-JOHNSON
RIVITORS AIR AND HYDRAULIC CYLINDERS CUTTERS CLINCHORS



THE BASE of a Huntercraft Candelabra Model 8008 (shown below) requires, with Formbrite, only a finish buff. The base is formed in two drawing operations. The deeper drawn candle cups, also of Formbrite, need only a light cutting with Tripoli and a finish buff.

It's easy to get a jeweler's finish with Formbrite

HUNTERCRAFT Table or Wall Candelabra Model 8008, one of 30 fine brassware items in the line of Huntercraft Originals.

"Formbrite cut polishing cost and time dramatically—was a major factor in keeping our small business alive . . . and growing," says Ralph E. Hunter of Huntercraft.

THE production of Huntercraft Originals—now a nationally distributed line of fine brassware—has grown from a basement hobby to a thriving new business in less than 5 years.

The Hunter Machine Service Company of Racine, Wisc., began manufacturing Huntercraft Originals on a commercial scale in 1951, using ordinary soft forming brass. To get the gleaming jeweler's finish required, polishing time and costs were high. In fact, they were so high that the young company found it impossible to bring their prices into line with competition.

In 1953, they tried Formbrite®, Anaconda's superfine-grain drawing brass. The polishing bottleneck was broken and production soared – unit costs went way down. According to Ralph E. Hunter, owner and president of Hunter Machine Service Co., Formbrite was a major factor in keeping the company alive and enabling it to go on to become a stable, growing business. The finish obtained so easily on Formbrite, he adds, is superior to that achieved on ordinary drawing brass.

Formbrite is a premium product at a nonpremium price. Find out for yourself how its superfine-grain, excellent drawing properties, strength, and scratch-resistance can help you make a better product at lower cost. Write for Publication B-39. Better yet, ask for a sample or a trial batch. Address: The American Brass Co., Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont. 5672

Formbrite SUPERFINE-GRAIN DRAWING BRASS

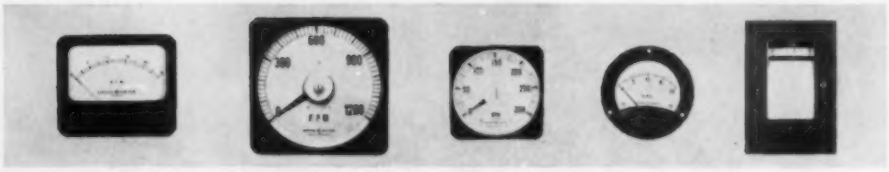
an ANACONDA® product

made by The American Brass Company

General Electric Speed Measuring Systems:

Handsome Appearance and Top Quality Increase Customer Acceptance and Resale Value

G-E application engineering and fast shipment help you get the right system when you need it



COMPLETE LINE of indicators and recorders to choose from offers you the exact type speed measurement you require.

General Electric speed measuring systems are offered in a complete line for every application; each system you buy is *tailor-made* to meet your requirements.

Here are 9 reasons why you get optimum performance for your investment with G-E speed measuring systems:

1. Handsome appearance of G-E indicators contributes to the good looks of your product and increases salability.

2. Top quality of every instrument assures you of extreme reliability under severe conditions.

3. High accuracy of ±1% of full scale is made possible by factory calibration of generator and indicator together.

4. Small size of both generators and indicators gives you greater latitude when selecting a mounting position.

5. Excellent readability of indicators is provided by long scales and large numbers. Non-parallax glass of DB-16 and DB-18 indicators allows reading from almost any angle.

6. Totally enclosed, both generators and indicators are fully protected from dust and dirt. Explosion-proof enclosures are available on some models.

7. Fast shipment of complete systems helps you meet commitments.

8. G-E application engineering is available to you on request to help you solve your speed measuring problems and select the proper equipment.

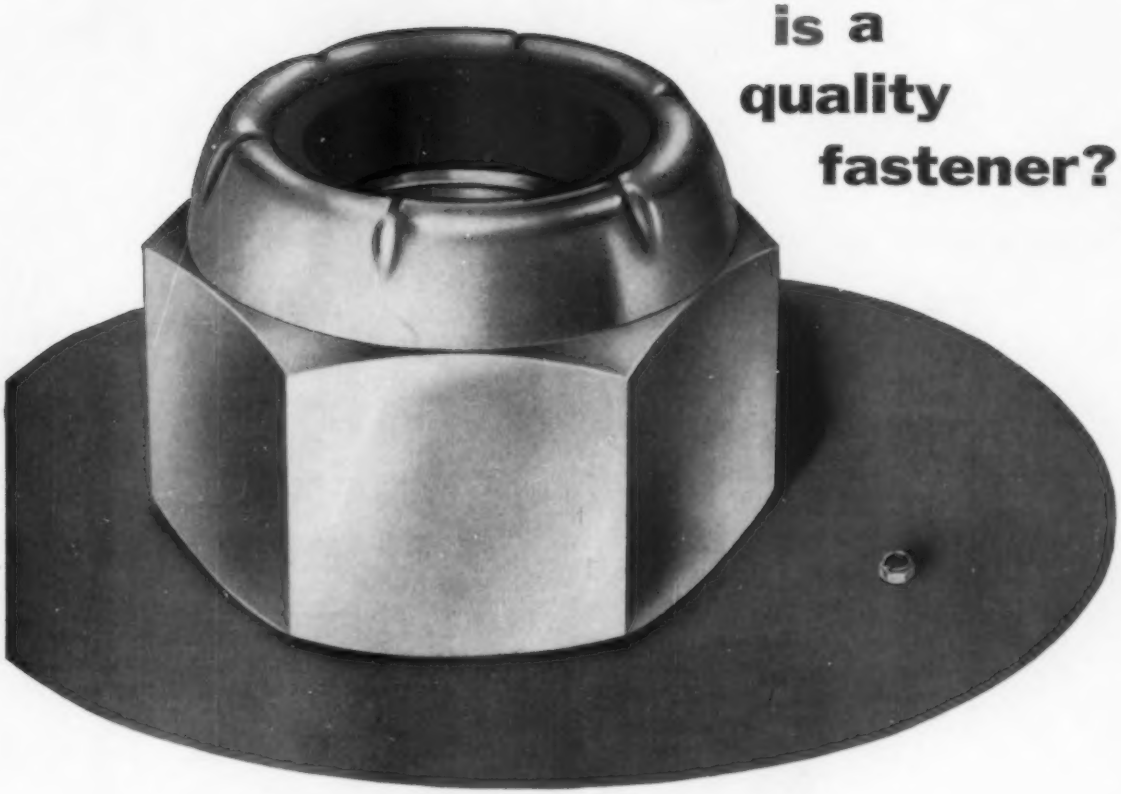
9. Any legend you require will be marked on your G-E tachometer indicator scales. Your instruments may be calibrated in units such as feet per minute, inches per minute, spindle rpm or any related speed. Manufacturer's or customer's name may also be imprinted on the scale face.

If you would like additional information on General Electric's complete line of speed measuring systems, call your nearest General Electric Apparatus Sales Office or write for Bulletins GEC-1258 and GEA-6427 to Section 585-57, General Electric Company, Schenectady 5, New York.

EXCEPTIONAL ACCURACY is made possible because generator and indicator are calibrated as a unit at the factory.

GENERAL ELECTRIC

What size is a quality fastener?



Here are two ELASTIC STOP® nuts.
Each has the familiar red locking collar. Each is self-locking, vibration-proof and can be reused many times. Each is a fast, readily assembled one-piece unit . . . will maintain accurate adjustment anywhere on a bolt. Each will afford positive protection against thread corrosion . . . prevent liquid seepage along bolts. Each is manufactured in quantity. Each is exactly controlled as to quality of raw material, finished dimensions, class of thread fit, seat squareness and finish. Each has a record for precision and uniformly high performance that is unmatched.

But . . . one measures 1/10 inch across the flats; the other, 4 inches. Between these two, there are more than 530 different hex nuts in the ESNA line. They are the result of variations in height, material, finish and size.

Look to ESNA for the top quality self-locking fastener that fits your need best.

ELASTIC STOP NUT CORPORATION OF AMERICA

ESNA TRADE MARK

ROLLPIN TRADEMARK

Elastic Stop Nut Corporation of America
Dept. N53-122, **2330 Vauxhall Road, Union, N. J.**
Please send the following free fastening information:

☐ ELASTIC STOP nut bulletin

☐ Here is a drawing of our product. What self-locking fastener would you suggest?

Name_____ Title_____
Firm_____
Street_____
City_____ Zone_____ State_____

Between motors and machines...

V-Belt Drives Run Your Plant

Texrope drive transmits power from Allis-Chalmers 300-hp motor to crusher used in copper ore processing.

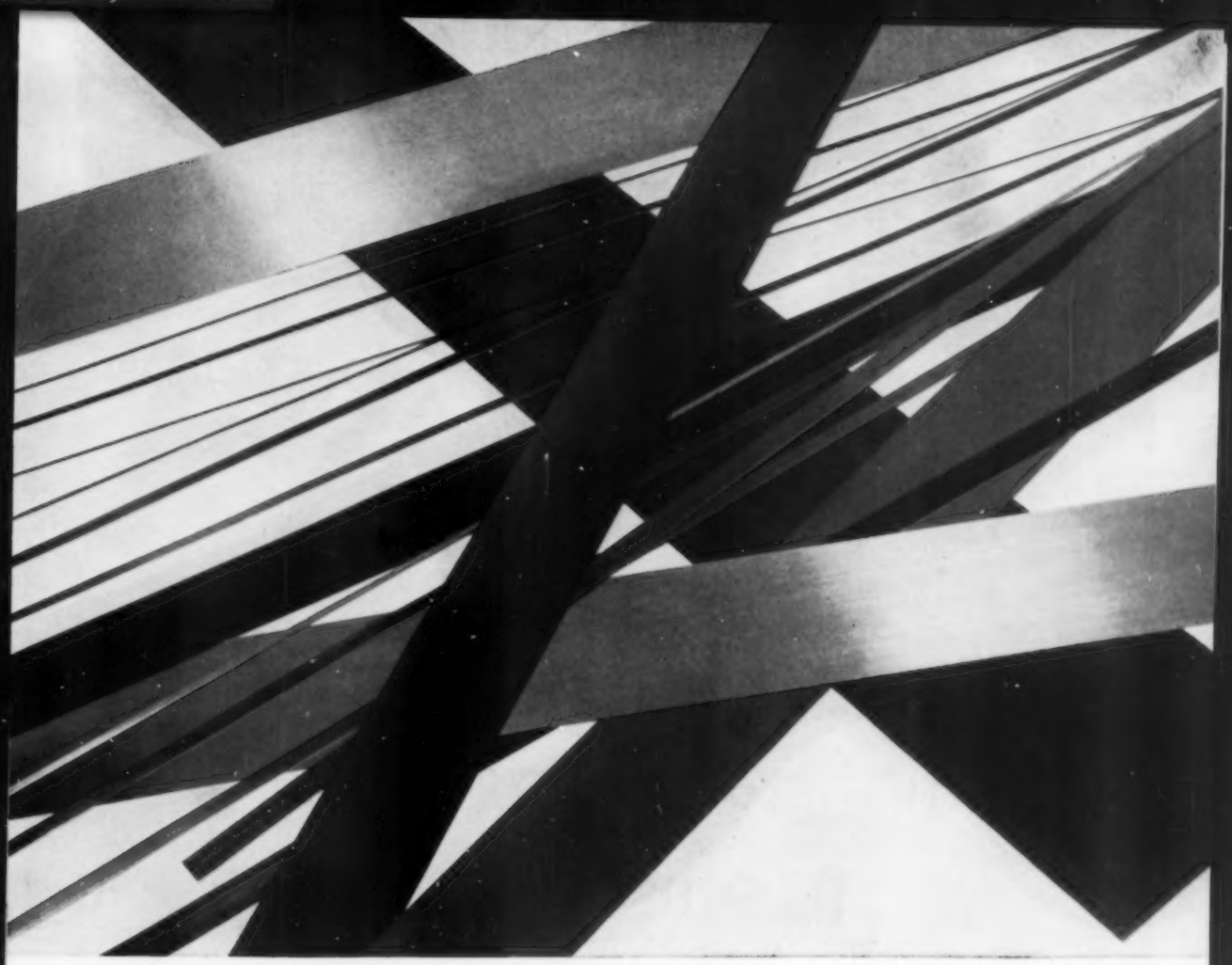
V-BELT drives are the vital link connecting power and production line. As such, they must install easily, combine high efficiency with dependability, and require minimum maintenance.

All these "vital link" characteristics are designed into *Texrope* V-belt drives by Allis-Chalmers, originator of multiple V-belt drives. *Texrope* drives feature specific advantages such as: *Magic-Grip* sheaves with "easy-on, easy-off" construction; the grommet belt which lasts 40% longer and costs no more than ordinary belts; and the *Vari-Pitch* sheave — the low-cost way to obtain variable speeds.

Whatever the application, there's one best *Texrope* drive to do the job most efficiently and economically. To find out more, contact your nearest Allis-Chalmers distributor, or write Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin. A-4696

Texrope, Magic-Grip and *Vari-Pitch* are Allis-Chalmers trademarks.

ALLIS-CHALMERS



How these "educated" steels make products behave better

● Nobody will deny that there can be a vast difference between steels that are supposedly alike. The difference lies in "tremendous trifles" that often make all the difference between smooth and erratic fabrication or between satisfactory and faulty product behavior.

That's why the steels shown above are "educated", you might say—educated for special use. Because here at the *Athenia Steel Division* of National-Standard we've concentrated for years on learning about and *controlling* those tremendous trifles! In turn, this learning and experience is put right into the Athenia steels that successfully meet many of the toughest assignments known today.

If your production calls for cold rolled flat steels of .45 carbon or higher, from .015" to 16" wide and from .001" to .065" thick, it would be a good idea to explore Athenia quality, performance and service.

NATIONAL-STANDARD COMPANY • NILES, MICHIGAN
Tire Wire, Stainless, Fabricated Braids and Tape

ATHENIA STEEL DIVISION • CLIFTON, N. J.
Flat, High Carbon, Cold Rolled Spring Steel

REYNOLDS WIRE DIVISION • DIXON, ILLINOIS
Industrial Wire Cloth

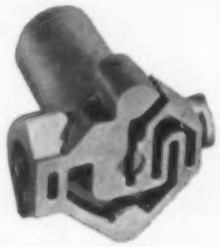
NS
NATIONAL-STANDARD
Company
NILES, MICHIGAN

WAGNER LITHO MACHINERY • JERSEY CITY, N. J.
Special Machinery for Metal Decorating

WORCESTER WIRE WORKS DIVISION • WORCESTER, MASS.
Round and Shaped Steel Wire, Small Sizes

CHARACTERISTICS OF CENTRAL FOUNDRY SHELL CASTINGS THAT WIDEN THE LATITUDE OF **product design**

intricate designs which are not practical with sand-castings, can frequently be produced in volume by the CENTRAL FOUNDRY SHELL MOLD PROCESS. Deep pockets can be drawn with a minimum of pattern draft. Pieces can be cast which have grooves and recesses without the need of additional cores, and the relationship of holes to the body portion can be maintained. The governor body is an example of this characteristic of shell castings.



closer tolerances can be held with shell castings than with green sand castings. The transmission drum is a typical example of a piece that gained by being held to very close dimensions. This factor can affect product design by making it possible to take advantage of the strength of alloy grey iron or ArmaSteel in a piece that might otherwise have to be die-cast in a soft metal.

the better dimensional control of shell castings makes it possible to substantially alter the design of a piece. Narrow spaces between counterweights in a crankshaft, for example, can be produced that are impossible in a forging.

smoother surfaces • Shell casting permits excellent duplication of surface detail. The engineer designing a piece that should possess high strength, but also some detail as to surface (such as cast-in lettering) may now find the answer in a shell casting.

shell coring produces more accurate internal surfaces. Because shell cores are cured in the corebox, intricate shapes are possible.

So many characteristics of CENTRAL FOUNDRY shell castings permit improvement in design, in material and in net cost that design engineers in many industries are specifically recommending these castings of grey iron, malleable iron or ArmaSteel. For further engineering data write for new 36-page shell casting manual . . . just completed.

74

CENTRAL FOUNDRY DIVISION

GENERAL MOTORS CORPORATION • SAGINAW, MICHIGAN • DEPT. 10

MULTI-FLEX

A Versatile Line of Boots, Connectors, Bellows, Tubes, Air Ducts

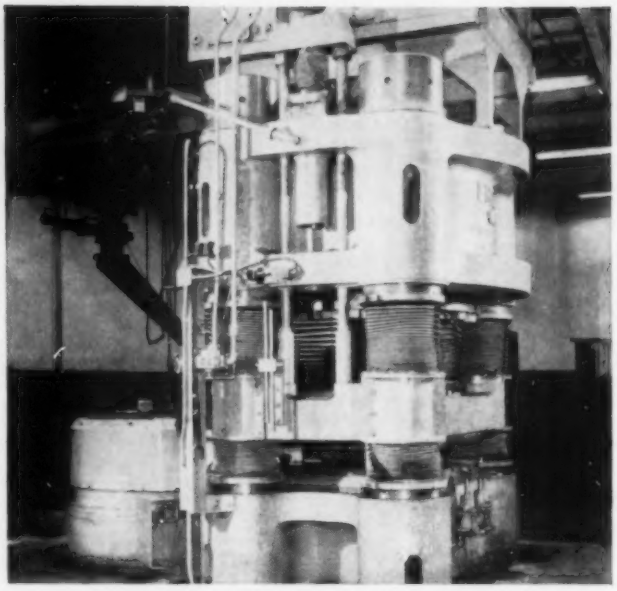
If the equipment you make requires

- accordion protective boots
- connectors to take bends or movements in compression or extension
- bellows to move air or be actuated by air
- extremely flexible tubing that will not kink

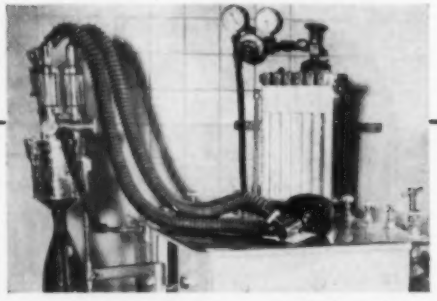
you'll do well to investigate U. S. Multi-Flex.®

Made circumferentially corrugated without molds or other tooling, in inside diameters ranging from ¼" to 48", and engineered to your particular requirements, these products may furnish the answer to difficult-to-solve application problems.

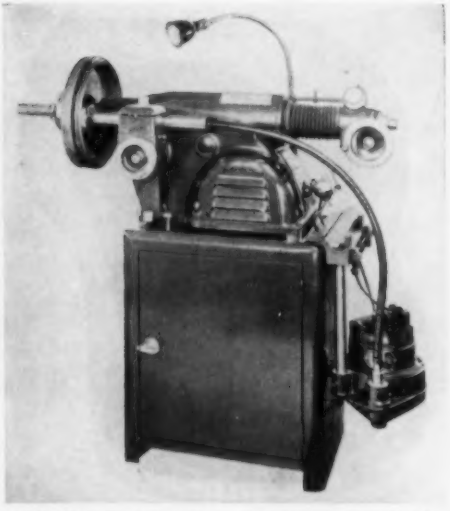
Get U. S. Multi-Flex, plus expert engineering service, at any of the 28 "U. S." District Sales Offices, at selected distributors, or by writing us at Rockefeller Center, New York 20, N. Y. In Canada, Dominion Rubber Co., Ltd.



Multi-Flex laced boots keep dirt and grit out of hydraulic rams. They are laced for easy installation without dismantling press.



Multi-Flex conductive tube—extra-flexible and lightweight—in use on anesthesia equipment.



Multi-Flex boots giving constant protection to the shaft on this brake drum lathe.

Multi-Flex connectors on vacuum filter, taking care of axial movement and misalignment.

Mechanical Goods Division

United States Rubber

How TIMKEN® bearings maintain spindle precision, accurate gear mesh on extra heavy-duty lathe

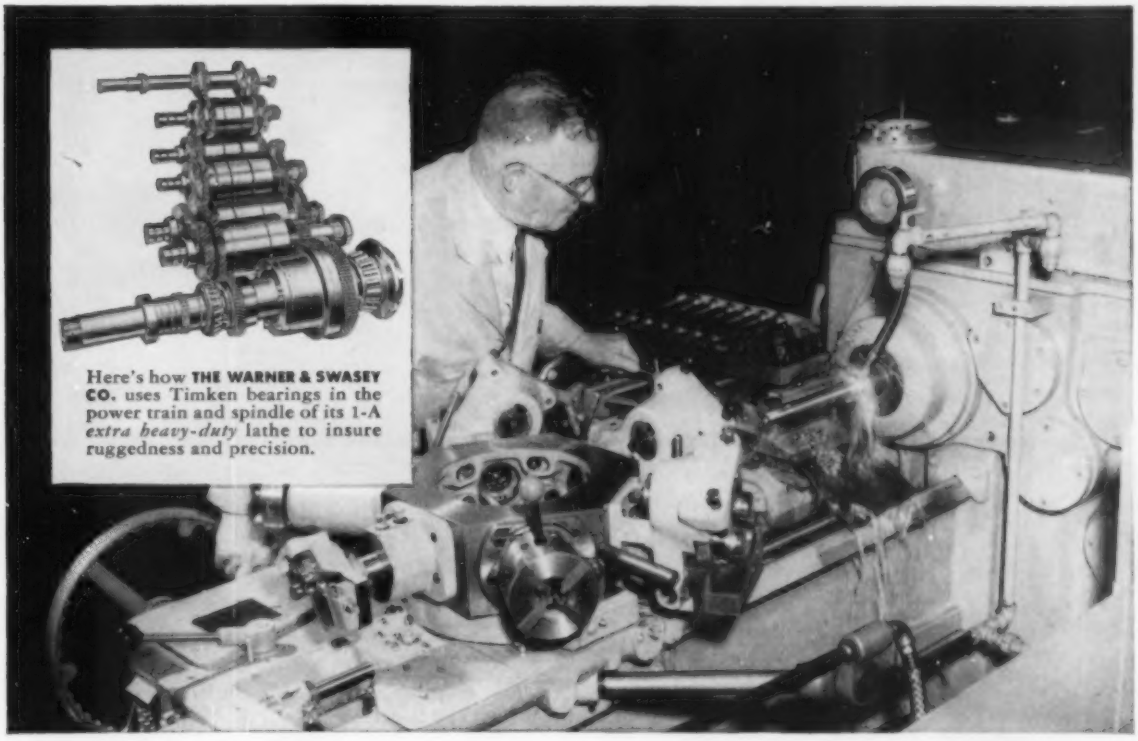
AT the flick of a lever, the operator of this Warner & Swasey 1-A *extra heavy-duty* lathe can get any one of 16 spindle speeds immediately. Then, with the right speed for the job, this lathe can hog off a lot of metal fast—and still turn out close-tolerance parts.

To help assure both precision and ruggedness, at any speed, Warner & Swasey engineers have mounted the spindle and gear train on Timken® tapered roller bearings. Timken bearings maintain spindle precision and accurate gear mesh day in and day out, piece after piece. They're tapered to take both radial and thrust loads, in any combination. Full line contact between rollers and races provides maximum capacity. Shafts are held in alignment. Gear mesh is smoother, more accurate. Shaft wear is eliminated, gear wear reduced.

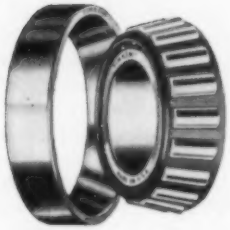
True rolling motion, plus almost microscopically smooth surfaces combine to make Timken bearings practically friction-free. They're made from Timken fine alloy steel. We're the only bearing manufacturer in America that makes its own steel. Rollers and races of Timken bearings are case-hardened for hard, wear-resistant surfaces and tough, shock-resistant cores.

No other bearings can offer you all the advantages of Timken bearings. That's why so many manufacturers of fine equipment use them. Whether you build or buy machinery, be sure to specify Timken bearings. And look for the trade-mark "Timken" stamped on every bearing. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.



Here's how **THE WARNER & SWASEY CO.** uses Timken bearings in the power train and spindle of its 1-A *extra heavy-duty* lathe to insure ruggedness and precision.



TIMKEN
TRADE-MARK REG. U. S. PAT. OFF.
TAPERED ROLLER BEARINGS

REVOLUTIONARY BUCYRUS PLANT HELPS HOLD DOWN RISING COSTS

At a new plant in Bucyrus, Ohio, the Timken Company has substantially reduced the cost of tapered roller bearings by: 1) producing these bearings under a new system of extreme mechanization; 2) standardizing on 13 bearing sizes with the widest applications throughout industry. Manufacturers can take advantage of these lower costs by redesigning applications to use these Bucyrus sizes. And as more switch to Bucyrus bearings, production costs can drop still further, meaning even lower costs to you.

NOT JUST A BALL ○ NOT JUST A ROLLER ⊂⊃ THE TIMKEN TAPERED ROLLER ⊂⊃ BEARING TAKES RADIAL ⫿ AND THRUST —⫿— LOADS OR ANY COMBINATION

Investigate the assembly savings made possible by P-K® self-tapping screws

Because P-K Type A Self-tapping Screws have clean, deep slots and sharp gimlet points . . . and because they are consistently uniform, Reznor Mfg. Co. enjoys important savings in the assembly of their gas heaters.

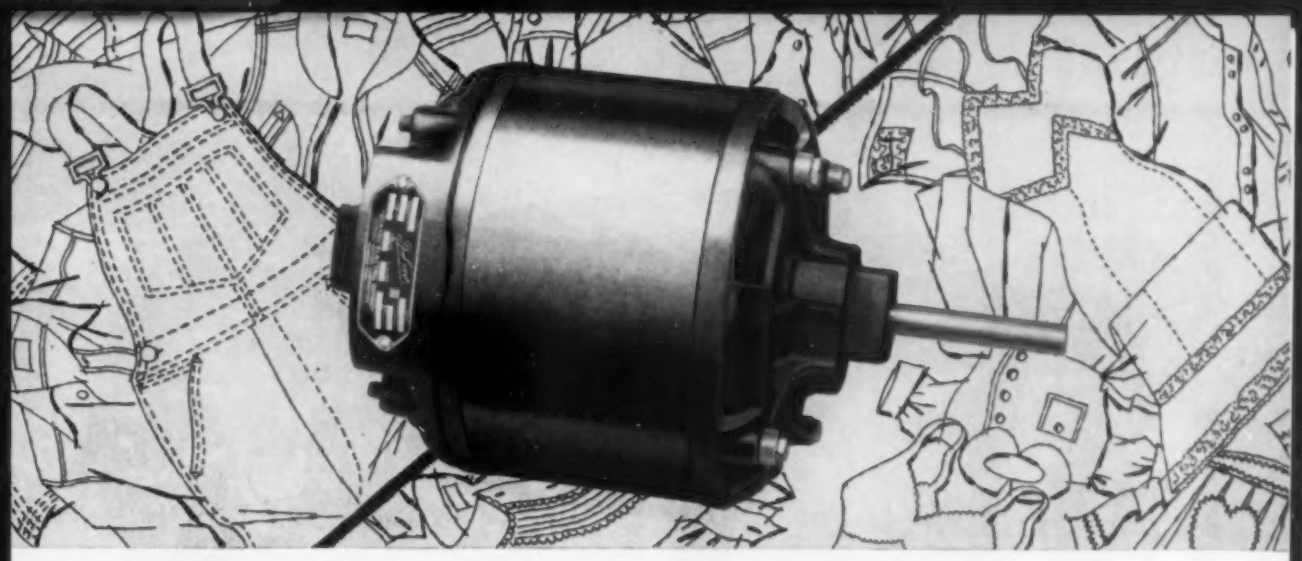
To hold the plastic handle halves of their Instant Heat Soldering Irons together, The Lenk Mfg. Co. specifies P-K Type F Self-tapping Screws. No need for a separate tapping operation. Production is increased and costs reduced—thanks to P-K Screws.

Melnor Industries, Inc. (formerly Melnor Metal Products Co.) puts assembly strength into their famous "Swingin' Spray" oscillating lawn sprinkler by fastening zinc and aluminum parts with P-K Self-tapping Screws—7 Phillips Head Type Z and 18 Type F. They start right . . . drive right . . . and stay tight.

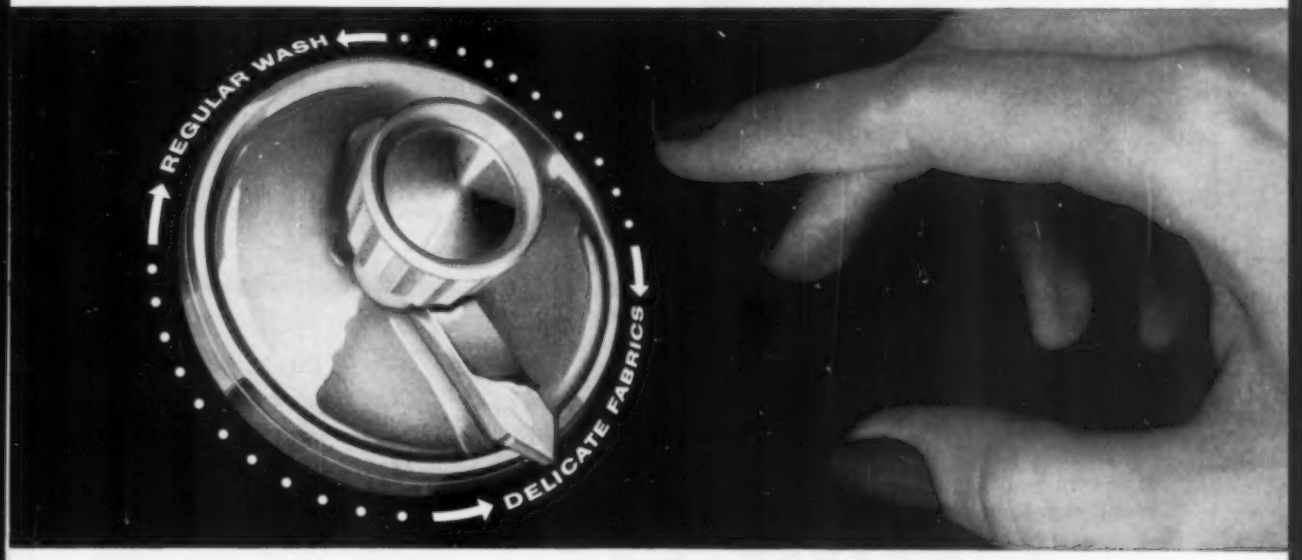
PARKER-KALON DIVISION, General American Transportation Corporation
Manufacturers of Self-tapping Screws, Socket Screws, Screwnails, Masonry Nails, Wing Nuts and Thumb Screws

PARKER-KALON® fasteners

Sold Everywhere Through Leading Industrial Distributors
Factory: Clifton, New Jersey—Warehouses: Chicago, Illinois—Los Angeles, California



PACKARD ELECTRIC / *NEW... custom-tailored washing machine motor*



FHP MOTORS / *Provides power for two washing speeds... electrically!*

It's an old idea based on need. Make the agitator speed variable. Then, both light and heavy clothes could be thoroughly washed without harming fabrics.

There were no two-speed appliance motors available with enough power at both speeds. Mechanical means, such as gears, belts and pulleys, clutches, etc., cost too much, took up too much space, made too much noise and caused too many maintenance problems.

A Packard Electric motor engineering team was first to solve the problem with a compact, two-speed unit that had just the amount of speed, power and torque required. And washing machine manufacturers who worked out the solution with Packard Electric engineers have had a big competitive advantage ever since.

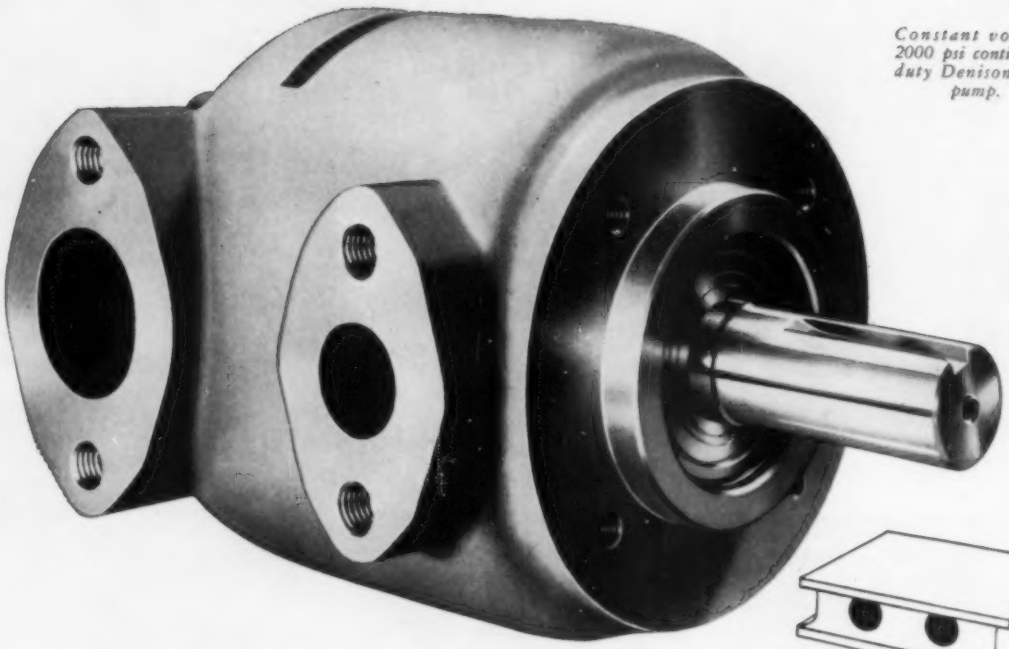
What's more, there are further savings in assembly when you buy Packard. That's because Packard will deliver a motor complete with special mountings and accessories to simplify your assembly procedures.

Packard Electric research and engineering teams have a long record of accomplishment in the custom-built motor field. And, even now, new ideas are on the boards to help our customers produce better, lower priced products for the appliances of tomorrow.

Packard Electric

Warren, Ohio — GM GENERAL MOTORS

Division of General Motors



Constant volume 2000 psi continuous duty Denison vane pump.

Hydraulically balanced vane utilizes internal oil pressure to maintain constant pressure of sealing edges against cam ring.

2000 PSI VANE PUMPS

Proper Application

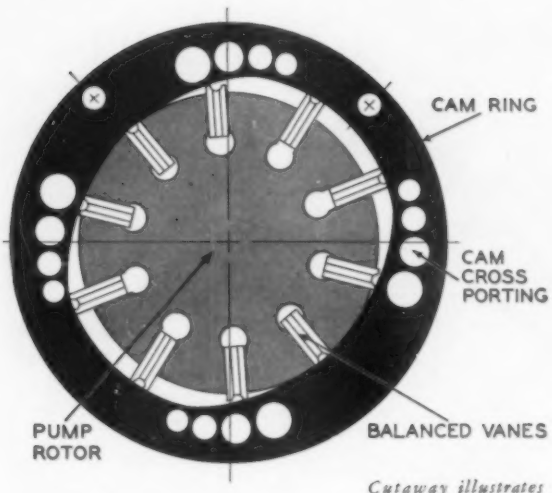
Hydraulic Performance

Operating Characteristics

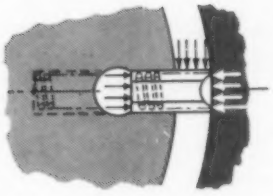
By Ellis H. Born
Chief Application Engineer
Denison Engineering Division
American Brake Shoe Co.
Columbus, Ohio

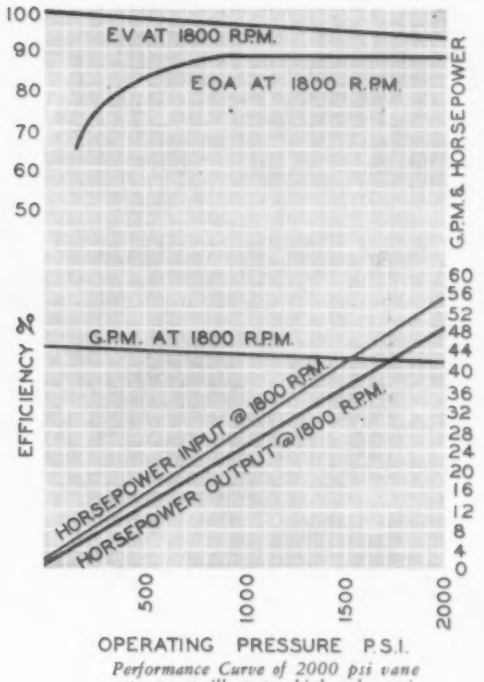
INEFFICIENCIES introduced by line loss are reduced 50% by increasing the pressure from 1000 to 2000 psi.

In designing hydraulic circuits, it is normal to limit line velocities to a maximum of from 15 to 20 feet per second, permitting the use of the smallest practical lines, valves and fittings. The pressure drop in transmitting the fluid medium is thus dependent on flow velocity, number of valves and fittings, and line length. If, for example, the pressure drop of a given system is 50 psi, this would represent a loss in transmission of 5% for a 1000 psi system and a loss of



Cutaway illustrates pump rotor and cam ring assembly. (Below) Pressure balancing relieves hydraulic bearing loads between vanes and cam ring.





Performance Curve of 2000 psi vane type pump illustrates high volumetric efficiency attained with double seal, balanced vane construction.

2.5% for a 2000 psi system. The power lost in transmission is thus reduced 50% by using 2000 psi components.

In sizing components for the transmission of a given horsepower, an interesting comparison of component size, weight and costs can be made. For example, if a job requires the transmission of 16 horsepower, a flow of 16 GPM at 2000 psi working pressure, or 32 GPM at 1000 psi, would be required. Thirty-two GPM would require 1¼" valves, but 16 GPM only ¾" valves. The use of the higher pressure results in a great advantage in that the hydraulic system can be set up with components of lower weight, lower cost per horsepower and smaller, more easily installed pumps, motors and valves.

Additional gains in hydraulic efficiencies are realized by the fully balanced design, not only on the rotor, but on the vanes themselves. Four years of field experience shows that high volumetric efficiencies are maintained over longer periods of service. Wear on cam rings is reduced over conventional designs where the vane is held against the cam ring by hydraulic pressure.

The balanced vane is achieved by a construction allowing the vane to be open at both ends to pressure on the pressure stroke, and to suction on the suction stroke.

Specifications and application data on this vane pump, which also operates as a hydraulic motor, are available by writing.

DENISON ENGINEERING DIVISION
American Brake Shoe Company
1194 Dublin Road, Columbus 16, Ohio

REQUEST FOR APPLICATION DATA

fill out and mail to
DENISON ENGINEERING DIVISION
American Brake Shoe Co.
1194 Dublin Road
Columbus 16, Ohio

Please send specific data on proper application of vane pumps for my needs. Problem is _____

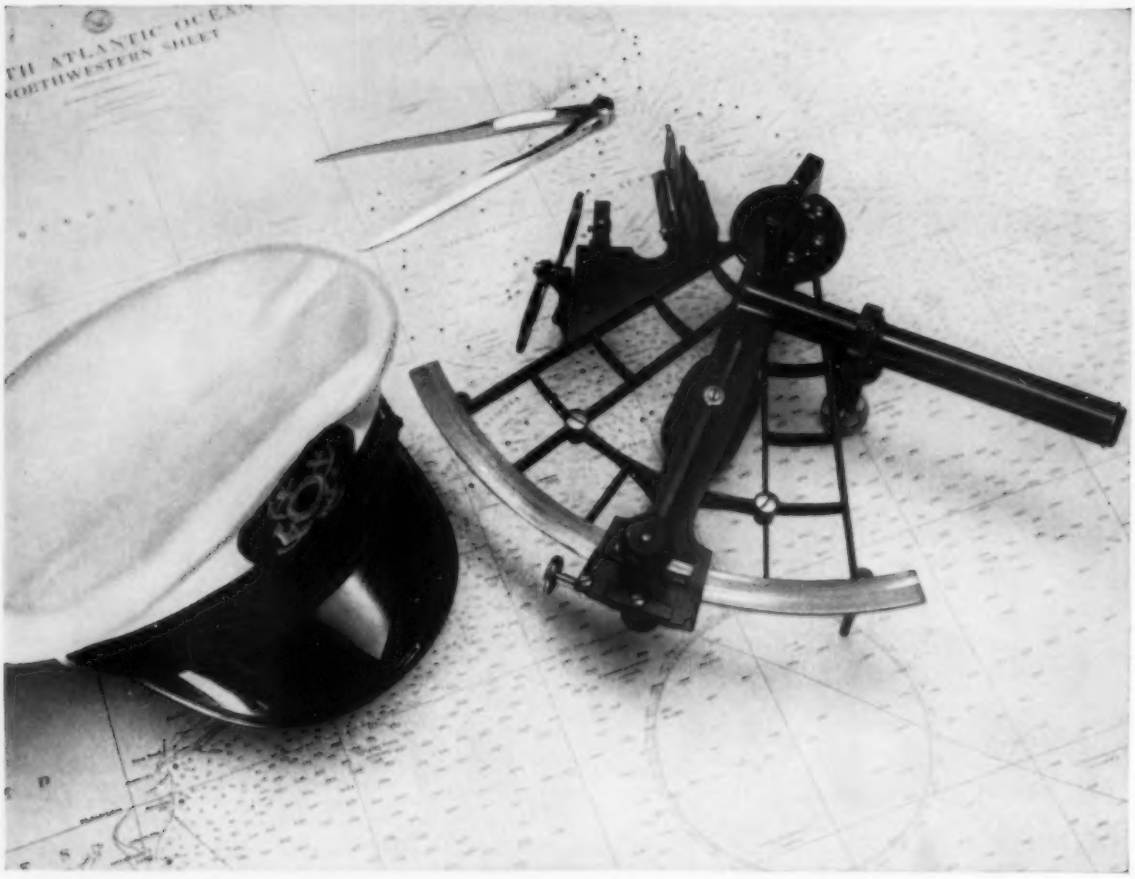
_____

Name of Company _____

City _____ *State* _____

Name _____

Position _____



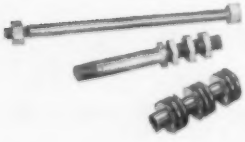
A combination . . . for going places

Laminated plastics . . . a combination of properties for doing things

Synthane laminated plastics work for industry in so many different ways because of their unusual combination of mechanical, electrical and chemical properties. Engineers in practically every major industry have put Synthane's many combination properties to work . . . providing unusual strength and toughness, high insulation resistance, low moisture absorption, good dimensional stability, and excellent resistance to corrosive acids, alkalies, salts and solvents in a variety of products.

DIELECTRIC STRENGTH

IMPACT STRENGTH



Synthane Power Shovel Parts. Electrical insulating ability and mechanical strength are the properties most needed in this application. The Synthane grade selected is also wear resistant, easily fabricated to precise dimensions, and can be laminated directly over metal cores for extra strength.

HEAT RESISTANCE

LIGHT WEIGHT

A Synthane grade for you! Synthane offers over 30 individual grades in sheets, rods, tubes, moldings and completely fabricated parts. Send for free illustrated catalog today.

SYNTHANE

SYNTHANE CORPORATION, 4 RIVER ROAD, OAKS, PA.

How Aeroquip Flexible Hose Lines Simplify Fluid System Design and Installation

TYPICAL AEROQUIP HOSE TYPES AVAILABLE

Aeroquip 1503 and 1502 Single Wire Braid Hose and Reusable Fittings are recommended for medium pressure hydraulic, lube and fuel oil, water and air lines up to 3000 psi. Sizes from 3/16" to 3".

Aeroquip 1509 Double Wire Braid Hose and Reusable Fittings are recommended for high pressure hydraulic, grease, fuel and air lines up to 4500 psi. In sizes from 1/4" to 2".

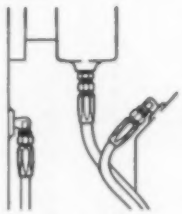
Aeroquip 2802 Teflon Hose and Reusable "*super gem*" Fittings are recommended for chemical, steam, hot asphalt and other corrosive fluid lines. In sizes from 1/4" to 1".

Aeroquip 1525 Cotton Braid Hose and *SOCKETLESS** Fittings are recommended for oil, fuel, air and water lines on engines and other applications up to 250 psi. In sizes from 1/4" to 3/4". *(Patent Applied For).

Write for full information

SOCKETLESS and "*super gem*" are Aeroquip Trademarks

More simplified and compact fluid system designs can be achieved in many cases through proper application of flexible hose lines. The basic design advantage lies in the fact fewer "parts" are required. A single flexible hose line can be used where elbows, formed tubing sections and assorted adapters are needed using rigid tubing or piping. Flexible hose lines also offer great advantage on fluid systems subject to flexing, vibration and stress.



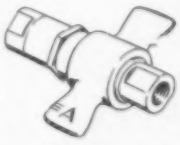
A wide variety of hose types is available to the designer. Aeroquip, for example, now produces 55 different hose types. Some have been developed primarily to carry special fluids. Others have been developed to withstand constant flexing, vibration, surge pressures, extreme temperatures.

REUSABLE HOSE FITTINGS

Aeroquip Hose Lines are unique in that every Aeroquip Fitting is detachable and reusable. In designing fluid systems, reusable fittings offer two advantages. First, mock-ups can be made and modified easily using hand tools to make up hose assemblies. Second, hose assemblies can be quickly made up in production quantities from bulk hose and reusable fittings without installation of expensive swaging machines in a manufacturer's plant. This benefit is also passed on to the equipment purchaser when replacement hose lines are needed. A small supply of bulk hose and a few spare fittings can be used to make quick replacements in the field. Aeroquip maintains an extensive network of distributors to serve users of Aeroquip Hose Lines.

SELF-SEALING COUPLINGS

Where fluid lines or systems require connection and disconnection for periodic inspection or maintenance, Self-Sealing Couplings can simplify design. Replacing two shut-off valves, a Self-Sealing Coupling permits disconnection of lines under pressure without loss of fluid or inclusion of air into the system. Aeroquip manufactures six types of Self-Sealing Couplings, for general industrial use, aircraft systems, Freon systems, LP-Gas fuel tanks, railroad diesel fueling and farm implement hydraulic systems.



FREE ROUTING AND INSTALLATION GUIDE

To help in planning and installing flexible hose lines, Aeroquip has prepared a handy 16-page guide covering flexible applications, bend radii, routing to avoid abrasion, heat damage, flexing failures, etc. Write for your copy today.

Complete engineering assistance is available to manufacturers.

Aeroquip Corporation,
Jackson, Michigan
Please send_____copies of "Guide for Routing and Installation of Aeroquip Flexible Hose Assemblies."

Name_____

Title_____

Company_____

City_____ Zone____ State_____

Aeroquip

REG. TRADEMARK

AEROQUIP CORPORATION, JACKSON, MICHIGAN

IN CANADA: AEROQUIP (CANADA) LTD., TORONTO 15, ONTARIO

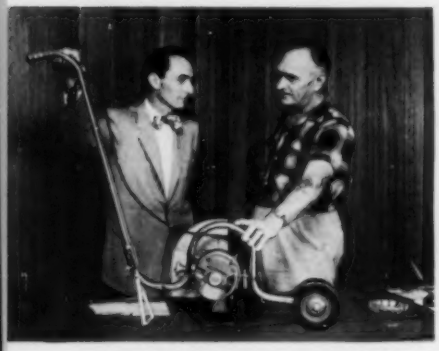
SOCKETLESS Fitting Patents: Great Britain 740,428; France 1,088,423; Austria 185,178—Patents pending in U.S.A., Canada, and other countries.

LOCAL REPRESENTATIVES IN PRINCIPAL CITIES IN U.S.A. AND ABROAD • AEROQUIP PRODUCTS ARE FULLY PROTECTED BY PATENTS IN U.S.A. AND ABROAD

RED JACKET MANUFACTURING CO.
"jet pumps cost less to ship"

LENNOX INDUSTRIES INC.
"we just install them and forget them"

W. M. WELCH MFG. COMPANY
"eliminated heavy mounting frames"



K & S MANUFACTURING COMPANY
"stands up under roughest handling"

ANTHONY MACHINE & ENG. SERVICE
"only motor versatile enough for us"

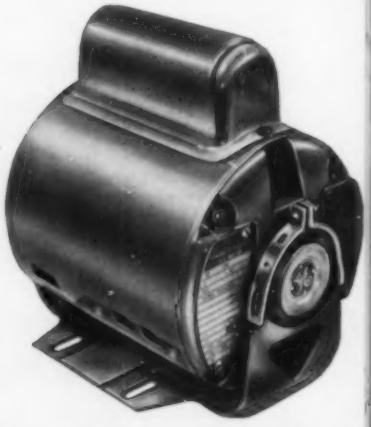
THE TRANE COMPANY
"reduced product weight nearly 8 lbs."

RUTHMAN MACHINERY COMPANY
"more compact, yet full-powered"

GE

Years Ahead

MOTOR



ALBERTSON & CO.—SIOUX TOOLS
"lighter, smaller—with power to spare"

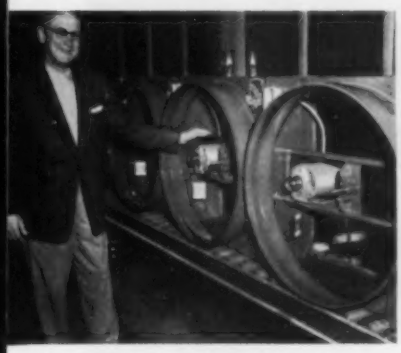
MODINE MANUFACTURING COMPANY
"dependable—in operation *and* delivery"

BARBER-COLMAN COMPANY
"cut manufacturing costs 12%"

AUTO-NAILER COMPANY
"All-angle mounting cuts design costs"

G. C. BREIDERT COMPANY
"as quiet as it is dependable"

LANCASTER PUMP & MFG. CO.
"G-E motors help sell our pumps"



BAR-BROOK MFG. COMPANY
" 'no re-oiling' feature rates high"

SOUTH BEND LATHE COMPANY
"top quality at competitive prices"

TEMCO, INC.
"light weight cut shipping costs"

16 More Companies Say...

LESS COSTS, MORE SALES with General Electric fhp motors

Yes—16 *more* manufacturers, like yourself, have reported on the cost-savings and sales-increases they've realized by incorporating General Electric "Years-ahead" motors into their products.

They are representative of the thousands of companies who have realized similar benefits—adequate proof that this General Electric fhp motor *can* save you money—*can* make your product more saleable.

And no wonder! The G-E "Years-ahead" motor incorporates a number of advanced design features to give you longer motor life, unsurpassed versatility, and a lighter, smaller, more streamlined design to match your own modern product . . . for example—moisture resistant Mylar* polyester film insulation; dependable, all-angle sleeve bearings; doubled lubrication life; removable, rotatable cradle base; and many others.

To find out how you can take greater advantage of these G-E motor benefits in your own product, contact your nearby General Electric Apparatus Sales Office, or write to General Electric Company, Section 702-30, Schenectady, N. Y.

*Registered trade-mark of Du Pont Company.

GENERAL ELECTRIC

Dempster-Dumpster—a truck-mounted fork lift designed to handle trash and other bulk materials, shown in dumping position. INSET: "Dacron" is the reinforcement in the V-belts on the 13-inch, 2-groove drive—increasing delivered horsepower, efficiency of hydraulic pump.

How the Dempster-Dumpster's V-belt drive efficiency was increased by premium V-belts reinforced with DACRON

REG. U.S. PAT. OFF.

The lifting and steering power of the Dempster-Dumpster generates from a single hydraulic pump driven by V-belts. To insure dependable, slip-free operation and positive starting at this important spot, Dempster Brothers, Inc., switched to premium V-belts reinforced with Du Pont "Dacron"* polyester fiber. During the six years since the change, the belts have been proving their superiority on hundreds of Dempster-Dumpsters in use throughout the country.

Slippage and stretching have been sharply reduced by the 40% greater strength of belts made with Du Pont "Dacron". Two premium V-belts now do the work formerly handled by three standard belts. The belts remain stable . . . deliver more horsepower from the pump. And the ability of these belts to withstand greater shock loading assures fewer replacements, more efficient, trouble-free operation.

In designing *your* next drive, investigate the advantages of premium V-belts made with "Dacron". They combine the unique properties of the "Dacron" yarn made by Du Pont and the highest skills of the leading V-belt manufacturers. For a list of manufacturers using "Dacron" in premium V-belts, write to E. I. du Pont de Nemours & Co. (Inc.), Textile Fibers Dept., Wilmington 98, Delaware. Premium V-belts shown in above photo were manufactured by the U.S. Rubber Company.

6 REASONS FOR USING PREMIUM V-BELTS REINFORCED WITH "DACRON"

- Transmit up to 40% more horsepower.
- Withstand greater shock loading.
- Longer flex life.
- Cut downtime.
- Low stretch.
- Require less maintenance.

"Dacron" in V-Belts DU PONT

REG. U. S. PAT. OFF. REG. U.S. PAT. OFF.

"Dacron" is Du Pont's registered trademark for its polyester fiber.

BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY

FREE! YOUR NEW ACTUATOR and SPLINE "PROBLEM SOLVER"!

New 1957 Engineering Data Book from World's Largest Producers of Ball/Bearing Screws and Splines

36 pages crammed with time-, work-, and money-saving facts: Principles • Types • Basic Operations • Coupling Methods • Efficiency • Versatility • Advantages • Selection Factors • Design Data • Sample Problems, etc.

SAGINAW b/b SCREWS are *90%-98% efficient* (compared to 15%-20% efficiency of Acme screws). Require ⅔ LESS torque and power for same linear output—with consequent weight, space reductions. Function normally at −75° to +250° F. Two types: precision-ground or commercial rolled-thread. Have been built 1½ in. to 39½ ft. long.

SAGINAW b/b SPLINES have *40 times lower coefficient of friction* than sliding splines; transmit or restrain high torque loads far better; permit vital power, weight, space reductions. Have been designed 3 in. to 10 ft. long.

Saginaw ball/bearing Screws & Splines

SAGINAW STEERING GEAR DIV., GENERAL MOTORS CORP., SAGINAW, MICH.

----- SEND FOR YOUR FREE COPY TODAY-----

Saginaw Steering Gear Division, General Motors Corporation
b/b Screw and Spline Operation
Dept. 1J, Saginaw, Michigan

Please send 1957 engineering data book on Saginaw b/b Screws and Splines to:

NAME_____

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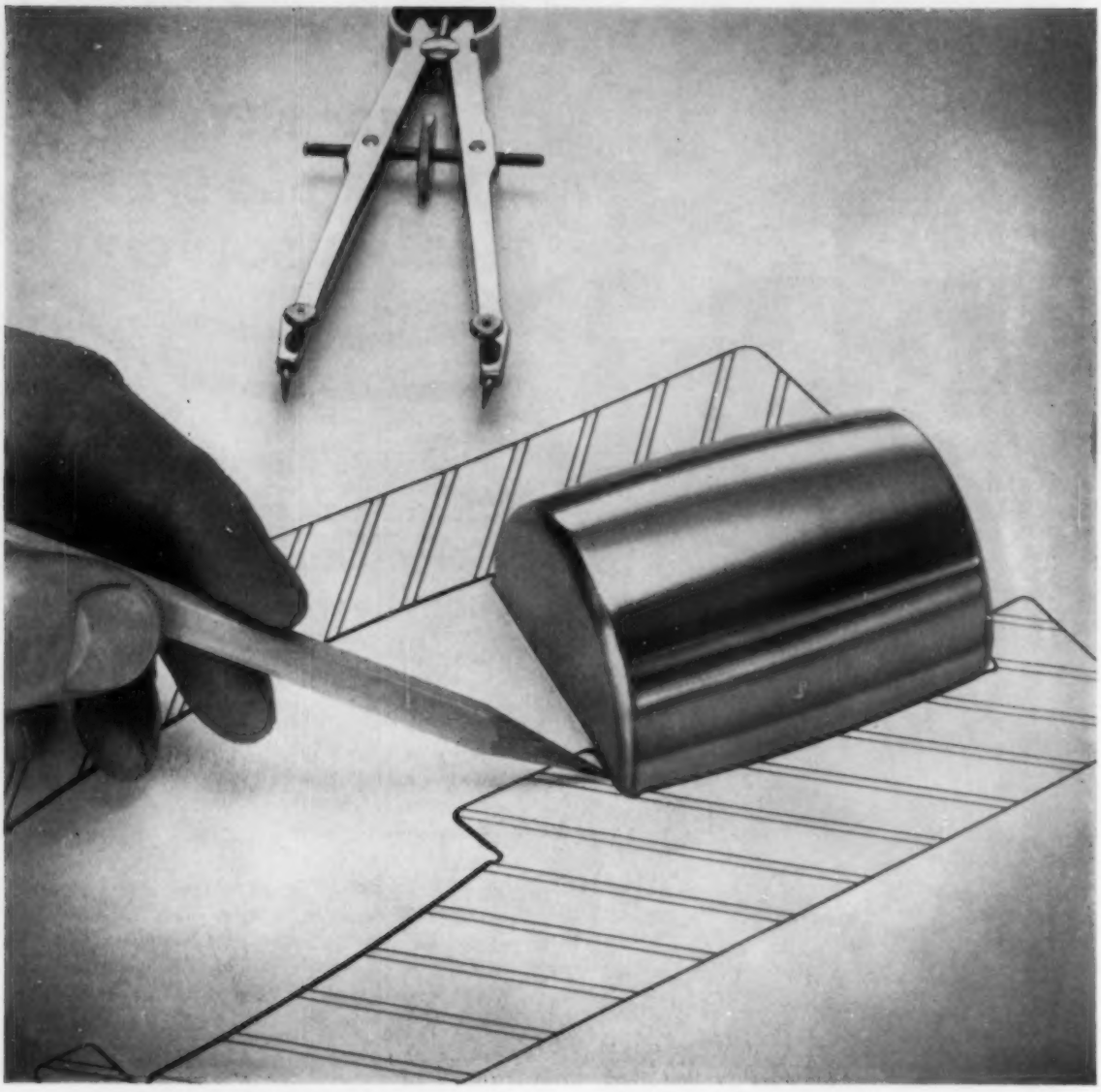
CITY_____ ZONE____ STATE_____

TORRINGTON *SPHERICAL ROLLER* BEARINGS



What a difference *conformity* makes!

TORRINGTON SPHERICAL ROLLER BEARINGS have the right degree of conformity between rollers and races and between roller ends and the center guide flange. "Skewing" is eliminated and rollers operate with a minimum of friction. This means even load distribution and long, low-maintenance service.

Because of their excellent performance in heavy-duty application, Torrington Spherical Roller Bearings have won wide acceptance in rock crushers, cranes, paper machinery, drilling rigs, presses—wherever high load capacity is required under conditions of misalignment.

Torrington Spherical Roller Bearings are available with either straight or tapered bore, for shaft or adapter mounting. And Torrington engineers have wide experience in custom-building bearings for special applications. Whenever you need bearings, call on TORRINGTON.

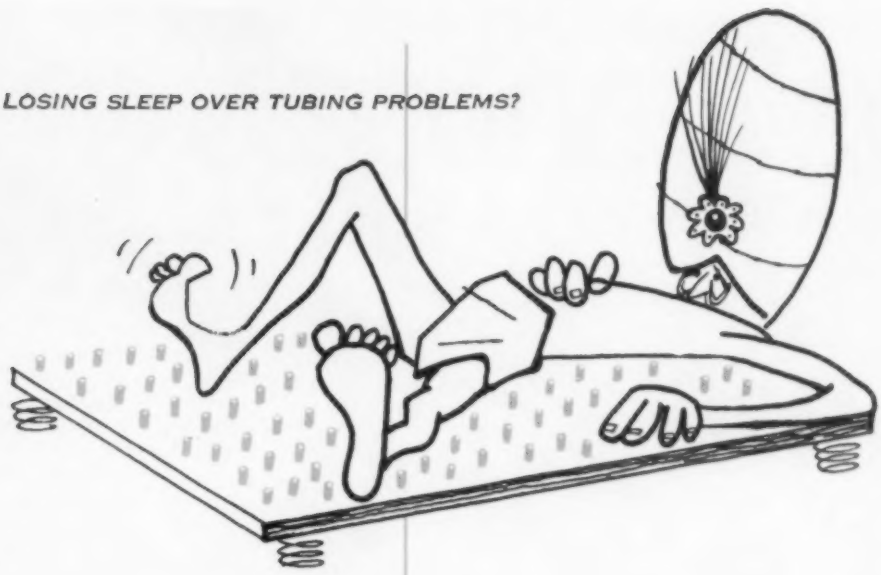
THE TORRINGTON COMPANY
South Bend 21, Ind. • Torrington, Conn.
District offices and distributors in principal cities of United States and Canada

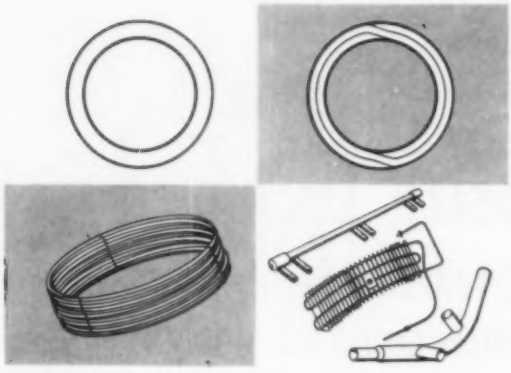
90th ANNIVERSARY 1866–1956

TORRINGTON BEARINGS

Spherical Roller • Tapered Roller • Cylindrical Roller
Needle • Ball • Needle Rollers

LOSING SLEEP OVER TUBING PROBLEMS?





GM Steel Tubing is available in single wall welded, double wall brazed... in continuous 2000-ft. coils or finished and fabricated to specifications!

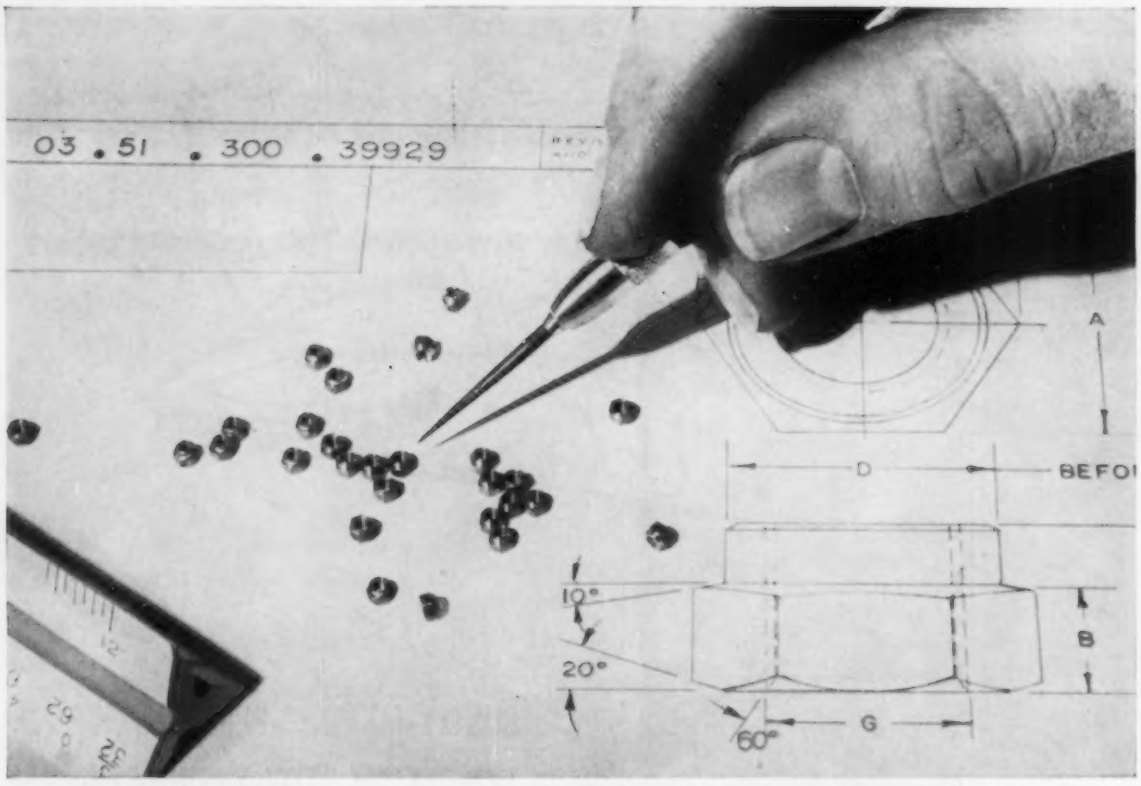
GET "COSTLY-METALS" PERFORMANCE . . . PLUS TYPICAL GM STEEL TUBING SAVINGS!

Why pay for more performance than you need or can possibly get? Costly metals are still being used every day in applications where rugged, dependable GM Steel Tubing does the job as well, or better, at almost half the cost.

For instance, where cleanliness counts, Rochester will *guarantee* you the cleanest tubing you can buy at *any* price! Consult Rochester Engineering. We'll be glad to consider your tubing problems and show you wherever GM Steel Tubing can help you cut costs. Just write us direct or call your Rochester Products Sales Engineer.

GM STEEL TUBING BY ROCHESTER PRODUCTS

ROCHESTER PRODUCTS DIVISION OF GENERAL MOTORS CORPORATION ROCHESTER N.Y.



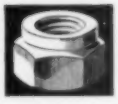
FLEXLOC MICROSIZE locknuts meet designers' needs for tiny precision nuts that retain strength and holding power in the smallest assemblies—servomechanisms, electronic and electrical equipment, all miniature devices.

New FLEXLOC Microsize Locknuts

Now available in Alloy Steel, Stainless Steel, Brass and Aluminum for lighter, more compact designs

SIZE	Across Flats		Shoulder Height		Across Corners	Height +.000 −.003
	MAX.	MIN.	MAX.	MIN.	MIN.	
0-80 NF-3B	.111	.107	.047	.042	.123	.075
1-64 NC-3B	.127	.123	.0635	.0585	.141	.090
1-72 NF-3B	.127	.123	.0635	.0585	.141	.090
2-56 NC-3B	.158	.153	.068	.063	.176	.105
2-64 NF-3B	.158	.153	.068	.063	.176	.105
3-48 NC-3B	.190	.183	.071	.066	.210	.120
3-56 NF-3B	.190	.183	.071	.066	.210	.120
4-40 NC-3B	.190	.183	.072	.067	.210	.120
4-48 NF-3B	.190	.183	.072	.067	.210	.120

SPECIFICATIONS: Available in brass (plain or cadmium plated) and aluminum (plain or chemically treated), for temperatures to 250°F; alloy steel, 18-8 stainless, for temperatures to 550°F.



New FLEXLOC Microsize locknuts are smaller and lighter than regular FLEXLOCS of the same nominal diameter. Wrenches of smaller size are used to install them. Mating joints or flanges can be designed smaller—with no loss in strength or convenience of assembly.

Microsize FLEXLOCS have all the advantages of larger FLEXLOCS. One-piece, all-metal construction—nothing to put together, come apart, lose or forget. Use them as lock or stop nuts—they stay put anywhere on a threaded member as soon as the locking threads are fully engaged. Uniform locking torques insure accurate preloading. There are no nonmetallic inserts to pop out or deteriorate. Moisture, dryness, oil won't affect these Microsize FLEXLOCS. Just screw them on. They lock and stay locked. Vibration won't shake them loose.

For complete information on Microsize FLEXLOCS, consult your authorized SPS distributor. Or write STANDARD PRESSED STEEL CO., Jenkintown 28, Pa.

STANDARD PRESSED STEEL CO.

FLEXLOC LOCKNUT DIVISION SPS

JENKINTOWN PENNSYLVANIA

DOW CORNING CORPORATION

Silicone News

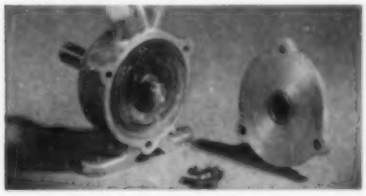
FOR DESIGN ENGINEERS No. 33

Pump Life Tripled with Silicone Lubricant for Plastic and Rubber

Chemically inert Dow Corning 3 Compound provides outstanding lubrication for moving plastic or rubber parts. Proof of its efficiency is provided by the Becher Pump Company, Chicago, Illinois.

Becher produces a positive-flow chemical pump incorporating a nylon planetary roller plus a vinyl guard and tube. The pump is designed to carry chemical slurries, liquids or gases without danger of contamination or reaction.

By sealing the pump with Dow Corning 3, thus lubricating both plastic parts and sleeve bearing, Becher engineers tripled the unit's service life while reducing power requirements by 50%. They further report



that introduction of the silicone compound so drastically reduced starting torque that they now employ a 1/25 hp, 1720 rpm shaded pole motor to do the work that previously required a more costly 1/12 hp split phase motor. (Cont. Pg. 2)

GIANT LOG STACKER ATTAINS GARGANTUAN POWER WITH SILICONE INSULATED MOTORS

Engineers designing large electrically powered equipment are attaining more power per pound while gaining the many advantages of placing the power unit closer to the work by using motors insulated with Dow Corning Silicones. An excellent example is the giant Electric Log Stacker produced by R. G. LeTourneau, Inc., Longview, Texas.

A separate high torque, a/c motor connects directly to every point of load — lift fork, hold-down tusks, boom tilt and rear axle steering. And there is a separate d/c motor inside each of the four rubber-tired drive wheels. A diesel-generator set supplies power to any or all motors on demand.

The work potential of these mechanical giants is worthy of Paul Bunyan. A single bite of the lift forks conveys up to 25 tons of logs; one stacker can move more logs

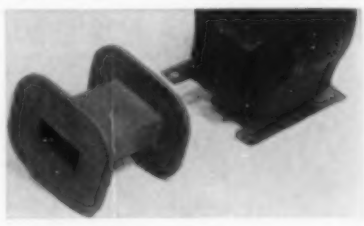
(Cont. Pg. 2)

Coil Bobbins of Silastic Resist Unusually High Voltage, Temperature

Combine high temperatures and high voltage and you'll quickly expose any weak link in an electrical insulation system. That's what happened when technicians at Transformer Engineers, Pasadena, California, tested conventional choke coils intended for use on aircraft fire control apparatus.

The tests revealed that conventional coil bobbins all too often developed "electrical punctures" in the tube-to-flange joints when subjected to 15,000 volts at 140 C (320 F) operating temperatures.

The problem was overcome, however, with bobbins molded in one piece of Silastic, the Dow Corning silicone rubber. Featuring excellent thermal stability and dielectric strength after prolonged exposure to high temperatures, their one-piece construction avoided tube-to-flange joints entirely. Over 3000 of them have been put into service in the last two years; not one failure has been reported to date. *No. 329*



CLASS H MOTOR STILL ON TEST AFTER 60,039 HOURS AT 240 C

At 10 A.M., June 6, 1946, a Class H insulated 10 hp motor was generator loaded to operate at its test temperature of 240 C in Dow Corning's motor test labs. Every 500 hours since it has been shut down and exposed to 100% relative humidity for 24 hours. As of 11 A. M. October 1, 1956, this motor was still on test after 60,039 hours at an average copper temperature of 240 C! That's equivalent to 367 years operation at the Class H temperature of 180 C.

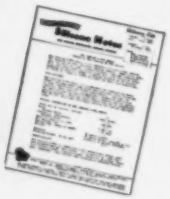
FOR DATA RELATING TO THESE ARTICLES, CIRCLE REFERENCE NUMBER IN COUPON ON NEXT PAGE

MORE

DOW CORNING CORPORATION

Silicone News

DOW CORNING PUBLICATIONS ON NEW DEVELOPMENTS AND TECHNICAL DATA . . . .



Parts fabricated of Silastic are now available from over 150 companies listed in recently revised reference. Conveniently located in or near most industrial areas, these companies are equipped to fabricate Silastic parts to meet every requirement, including coated fabric, ducting and hose, extrusions, gaskets and seals, molded parts, O-rings, rollers, specialty and sponged parts, wire and cable. *No. 334*

Documentary film "What's a Silicone?" available free of charge for showing to technical audiences. For more information circle *No. 335*

Primers and Adhesives for Silastic are listed in a compact reference sheet that compares methods of application and recommended cure times, all in easy-to-read tabular form. A handy and valuable aid to designers and engineers in selecting the product best suited for a particular application. *No. 336*

"Silicone Insulated Conductors," a reprint from WIRE AND WIRE PRODUCTS, describes and compares eight different types of silicone insulated wire and cable currently available for different applications. *No. 337*

Dow Corning Silicone Lubricants, including oils and greases, are described in a new, illustrated 8-page brochure that gives their properties, lists typical applications, and cites factors which contribute to obtaining longer life. *No. 338*

All New — 1957 Guide to Dow Corning Silicones is a twelve page, fact-filled catalog which briefly describes the silicone products of interest to most industries. Containing latest data and information, the guide is designed expressly to help you enjoy the advantages, profits, and savings made possible through imaginative use of these unique engineering materials. *No. 339*

Improve Percolator With Silicone Laminate At No Extra Cost

Designers who make imaginative use of silicones to increase the life and reliability of toasters, steam irons, and other appliances can often do so without adding a single penny to the cost of the finished product. A recent example is provided by Aluminum Goods Manufacturing Company, manufacturer of Mirro-Matic Percolators.

While Mirro-Matic's terminal pin insulators made of phenolic had proven satisfactory in normal use, the designers reasoned that abuse of the percolator could loosen electrical connectors and cause arcing. Phenolic is also prone to absorb moisture when splashed or dunked by careless users, raising a further possibility of insulator failure.

The risk of such breakdown, however, was entirely eliminated by the superior dielectric strength, heat and moisture resistance of silicone-glass laminates manufactured by Taylor Fiber Company. The moisture absorption of silicone laminate, for example, is only 0.02% compared with about 2% for phenolic.

And, because of the higher physical strength of silicone laminate, plain low cost stampings could be used instead of expensive molded parts. And they produced a further saving by reducing breakage during assembly.

The score: greater reliability for the Mirro-Matic Percolator without adding a cent to production costs! *No. 330*

SILICONE DAMPING FLUID KEEPS ACCELEROMETER ON THE "ALERT"

Because Dow Corning Silicone fluids show little or no change in damping force over a wide temperature span, many engineers are utilizing them to produce performance features and economies not possible with organic damping oils. Here's how M. Ten Bosch, Inc., Pleasantville, N. Y. did it:

Capitalizing on the inherent physical and chemical stability of Dow Corning 200 Fluid, Ten Bosch has designed an accelerometer weighing a mere 2½ ounces that retains a sensitivity of plus or minus .006 G at up to 6 Gravities. The time constant of the unit is only .0002, yet it has absolutely no undamped natural frequency.

Dow Corning 200 Fluid was selected as the "integrating fluid" for this unit after tests on dozens of other materials including motor oil, kerosene, mineral oil, water and air failed to meet Ten Bosch's requirements. Non-corrosive, non-conducting and non-gumming, the 200 Fluid permits the accelerometer to retain all of its original alertness and sensitivity over a wide temperature span in aircraft, missiles, and gyroscope direction service. *No. 333*

LOG STACKER *(Continued)*

in 5 minutes than three conventional yard lifts can handle in 30 minutes!

To provide maximum power and reliability every working motor — like all drive motors on all LeTourneau "electric wheel" equipment — is Class H insulated with Dow Corning Silicones. *No. 331*

TRIPLE PUMP LIFE *(Continued)*

Dow Corning 3 Compound dissipates heat so effectively the pump remains cool even when pumping dry. No decrease in capacity or pressure has been noted after 3000 hours' operation at 1750 rpm. *No. 332*

Dow Corning Corporation, Dept. 8612, Midland, Michigan

Please send me: 329 330 331 332 333 334 335 336 337 338 339

NAME _____

TITLE _____

COMPANY _____

STREET _____

CITY _____ ZONE ____ STATE _____

SILICONE NEWS is published for product design and development engineers by

DOW CORNING MIDLAND — *first in silicones* — DOW CORNING SILICONES — CORPORATION MICHIGAN

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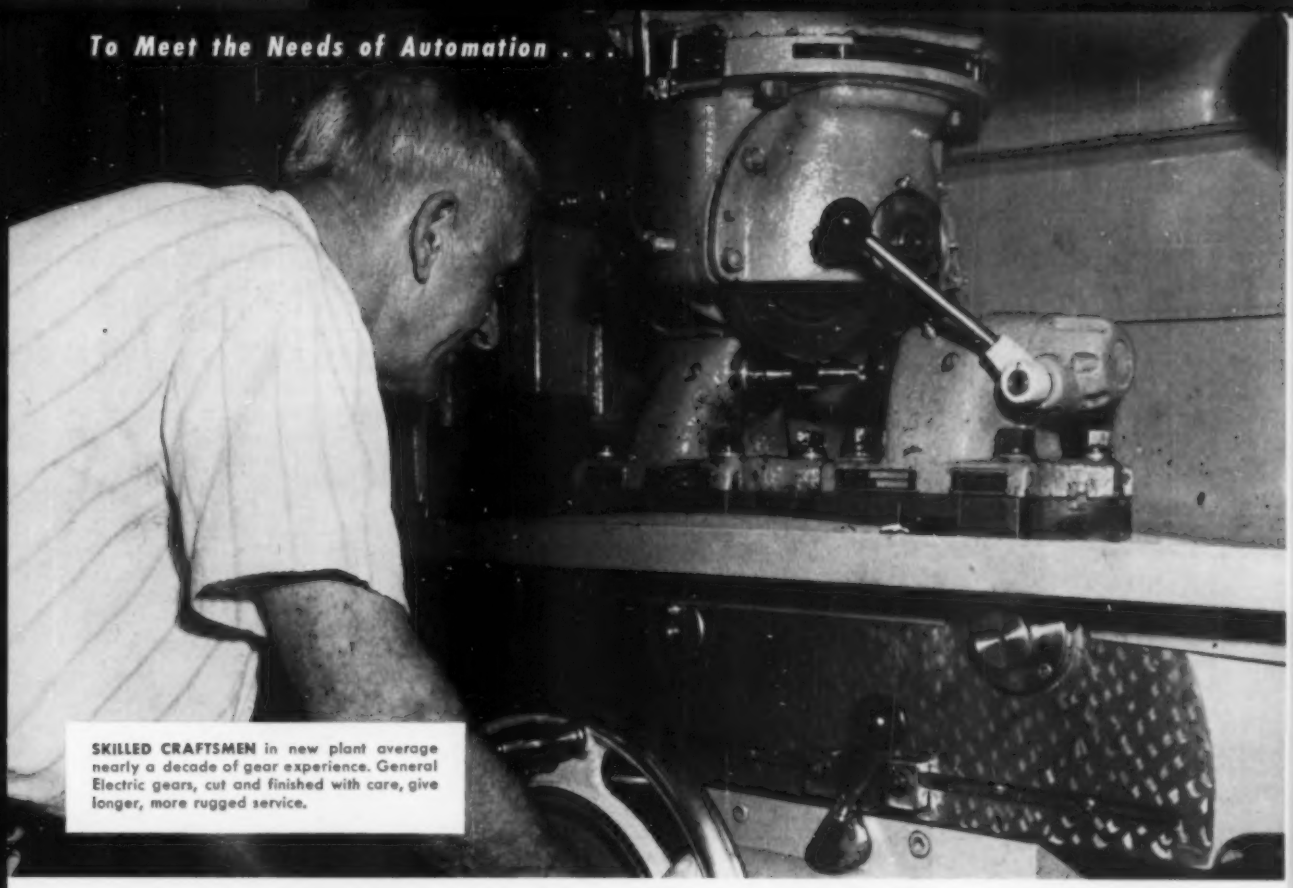
To Meet the Needs of Automation . . .



SKILLED CRAFTSMEN in new plant average nearly a decade of gear experience. General Electric gears, cut and finished with care, give longer, more rugged service.

At General Electric's NEW Gear Motor and Transmission Components Department . . .

3618 man-years of manufacturing know-how assure fast service on low-speed drives

To meet the increased demand for low-speed drives, General Electric's new decentralized Gear Motor and Transmission Components Department will be devoted solely to the design and manufacture of mechanical power transmissions.

•**Specialized Attention**—Highly trained and experienced gear-motor engineers and skilled craftsmen with over 3600 man-years of experience are available to help solve your low-speed drive problems. They are ready to give you fast, dependable G-E service on standards, on specials, and on new gear-motor products.

•**Complete Line Available**—General Electric offers a complete line of gear-motors—induction, synchronous, wound rotor, d-c gear-motors—in all types and enclosures, from 1/100 to 200 hp. The new department will also give you rapid service on special needs such as adjustable speed, braking, special mounting or special insulation.

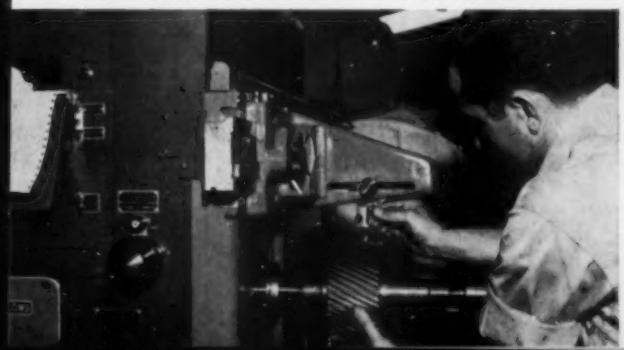
•**Fast Service**—The expanded gear-motor facilities allow quantity production and shorter manufacturing cycles. Machine tools in the new factory are designed for high volume precision work and are readily adaptable for the production of specials built to your specifications.

•**For More Information**—Write for bulletin GEA-6027, Section 851-2, Schenectady, N. Y., or contact your G-E Apparatus Sales Office or gear-motor supplier. Gear Motor and Transmission Components Department, General Electric Co., Paterson, N. J.

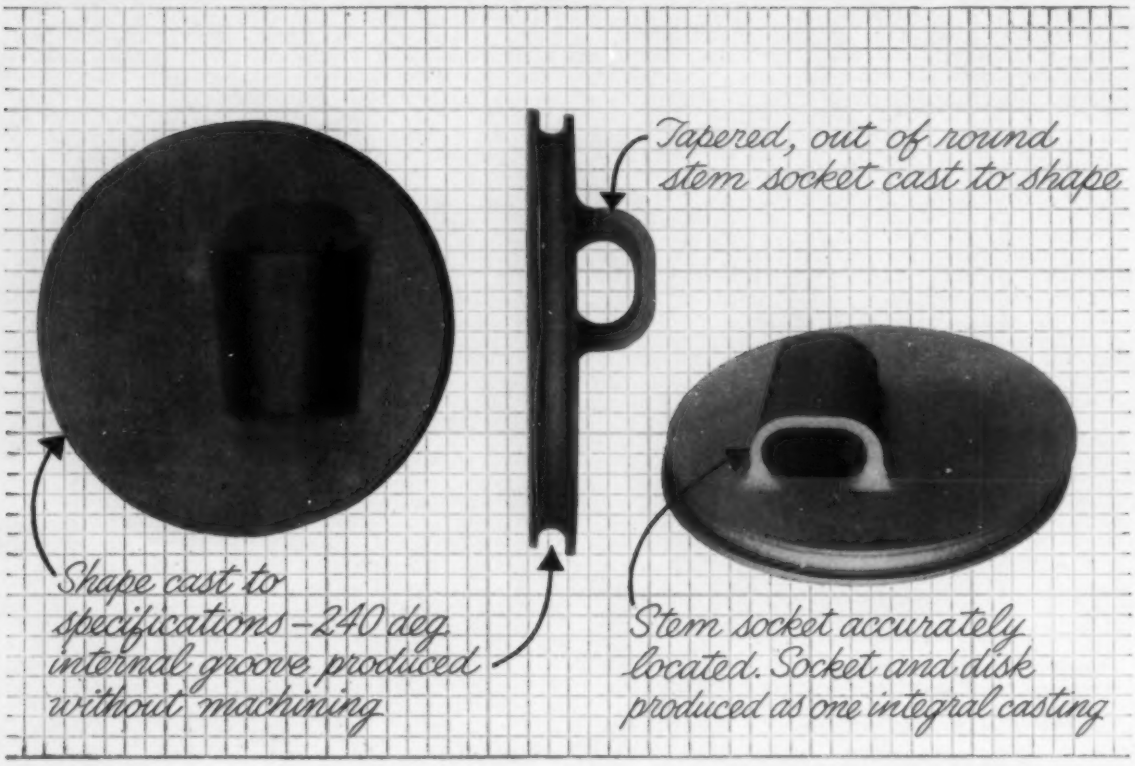
Progress Is Our Most Important Product

GENERAL ELECTRIC

CONTINUOUS TESTING provides data for quality control, new designs and developments. Here, an involute measuring instrument records wear, under simulated tortuous conditions, to nearest ten-thousandths of an inch.



QUANTITY PRODUCTION of complete line of G-E gear-motors from 1/100 to 200 hp, in all types and enclosures, assures prompt customer service. Specify General Electric for all your low-speed drive needs.


Tapered, out of round stem socket cast to shape
Shape cast to specifications – 240 deg. internal groove produced without machining
Stem socket accurately located. Socket and disk produced as one integral casting

Investment-Cast in One Piece . . . 5 Secondary Operations Avoided

This intricate valve disk and stem socket were investment cast at a considerable saving in machining, assembling, and joining costs. The disk is produced in an odd shape and has a concave rim with a 240-degree groove. There is a tapered, out-of-round recess in the stem socket. The disk and socket were designed and produced as one integral casting.

The shape of the disk, vital to the proper functioning of the part, was cast to size. A contour machining operation would have been required to produce this shape by other methods. The groove in the rim of the disk, and the stem socket, were also cast to size . . . thus eliminating two more difficult machining operations.

An assembly operation, which would have required precision locating devices, was also avoided. The stem socket had to be accurately located . . . 0.225 in. from the centerline of the disk. This location was held to within plus or minus 0.005 in. on the finished part by the investment-casting method.

Reducing production costs by eliminating secondary operations is only one of the many advantages of HAYNES' precision-investment-casting process. For the full story call or write to any of the District Sales Offices listed below:

HAYNES TRADE-MARK ALLOYS

HAYNES STELLITE COMPANY

A Division of Union Carbide and Carbon Corporation

UCC

General Offices and Works, Kokomo, Indiana

Sales Offices

Chicago • Cleveland • Detroit • Houston • Los Angeles • New York • San Francisco • Tulsa

"Haynes" is a registered trade-mark of Union Carbide and Carbon Corporation

DOW

Now and in the years to come, more and more products will become possible and practical with Styrex 767.

STYREX 767 opens new horizons for the plastics industry...*here's how–*

Here's real news! Styrex® 767, with superior crazing resistance, lends itself to applications previously considered impossible with thermoplastic materials. Plans heretofore unworkable can now be dusted off and brought to reality!

There are many reasons designers will want to start working with Styrex 767 right away–

An improved copolymer of styrene acrylonitrile, Styrex 767 is a rigid thermoplastic that is readily molded or extruded. It also has an excellent balance of physical properties. A high degree of toughness and heat resistance are combined with superb stress strength. It is resistant to acids, bases, salts, oils, waxes, soaps, food stains, and many solvents including gasoline and kerosene. Styrex 767 can be readily machined and decorative coatings are practical. It is available in natural color as well as transparent and opaque. Styrex 767 provides a new high standard of transparency in sparkling clear-toned colors. And Styrex 767 is already in full scale production, assuring availability of the product when you want it.

No matter what plastics you are using, you'll want to test this important contribution to the advancement of the industry–

Styrex 767 is the first of a family of new Dow plastics based on styrene acrylonitrile. Phone, wire or write for complete technical and application information. You'll find means to enlarge your markets, extend your fields of operation.

Dow Technical Service, with its extensive experience, is ready to help you. THE DOW CHEMICAL COMPANY, Midland, Michigan—Plastics Sales Department PL 430G.

you can depend on DOW PLASTICS

DOW

Let all these sealing engineers help you design-in oil seals

Why "do it yourself?" Why chance the wrong seal? Why risk costly retooling or remanufacture because an unforeseen condition rendered an oil seal helpless?

The finest oil seal counsel anywhere is yours for the asking. Just pick up the phone and call the nearest National Oil Seal Engineering office. You'll get complete, current information on newest seal developments, plus the help of the entire National Oil Seal Engineering group. Field and factory, these men devote their entire lives to seals. They have seen literally thousands of sealing problems through to a successful solution.

Let National's three decades of sealing experience help you. Call now.

Specify seals at the drawing-board stage—always!

NATIONAL SEAL
DIVISION, Federal-Mogul-Bower Bearings, Inc.
GENERAL OFFICES: Redwood City, California
PLANTS: Van Wert, Ohio and Redwood City, California

CHICAGO, ILL. . *Room 462, McCormick Building, HArrison 7-5163*
CLEVELAND, OHIO . *210 Heights Rockefeller Bldg., YEllowstone 2-2720*
DETROIT, MICH. . . . . *13836 Puritan Avenue, VErmont 6-1909*
INDIANAPOLIS, INDIANA . . *2802 North Delaware St., WAlnut 3-1535*
MILWAUKEE, WIS. . . . *647 West Virginia Street, BRoadway 1-3234*
NEWARK, N. J. . . . . *1180 Raymond Blvd., MItchell 2-7586*
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TO THE ESTABLISHED ADVANTAGES OF

POWDERED METAL PARTS

VOLUME PRODUCTION

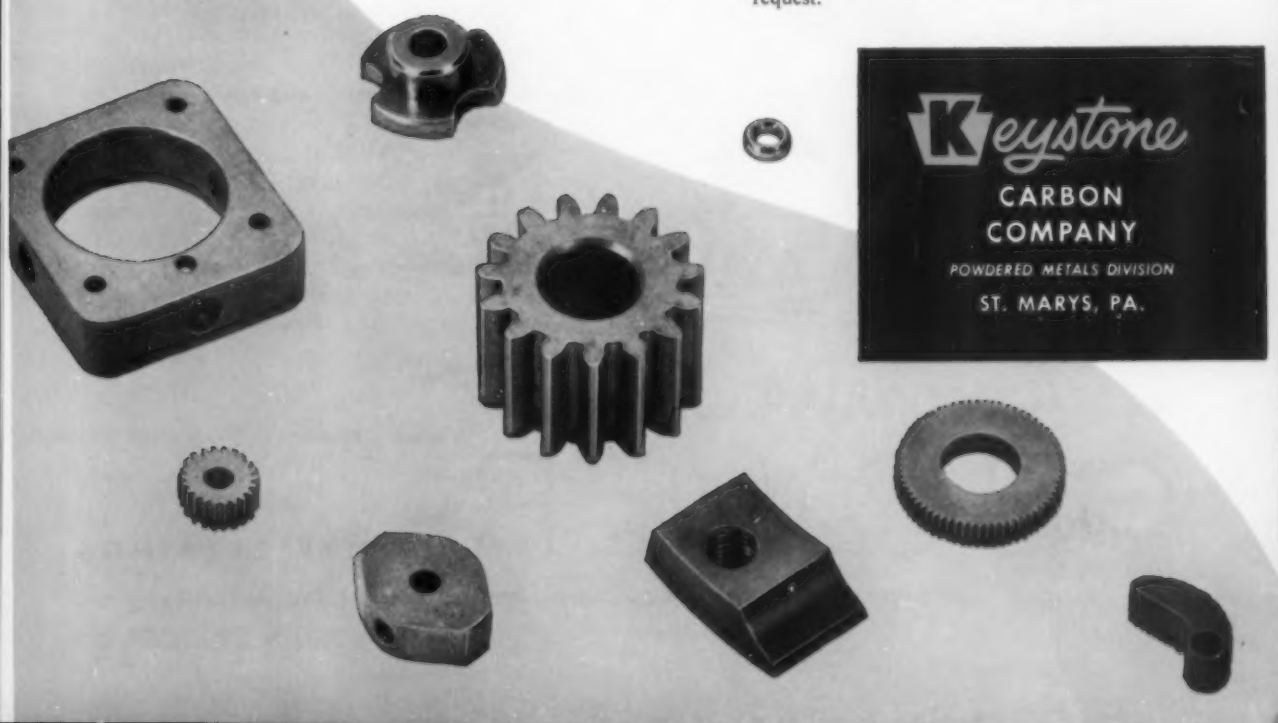
CLOSE TOLERANCES

ECONOMICAL FABRICATION

Keystone adds HIGH STRENGTH

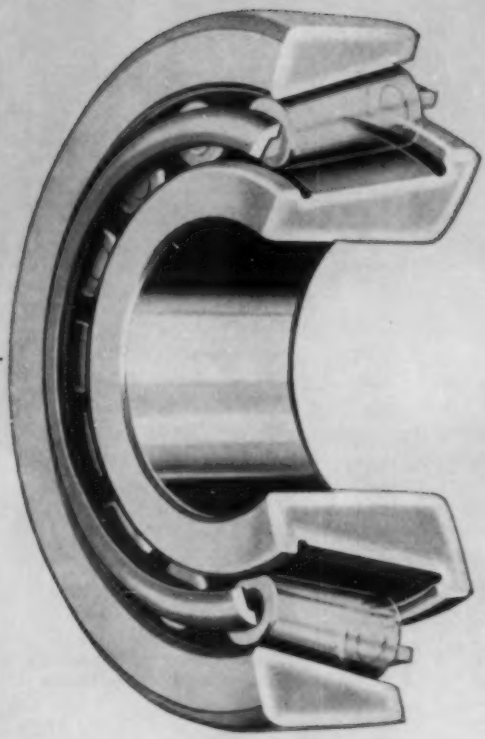
High strength, high density iron and steel parts are now available in large volume from Keystone for heavy duty applications. Keystone research and development with iron and prealloyed steel powders has paced the needs for materials of high tensile strength and hardenability—enabling successful parts production for rugged service demands. Typical of these are: gears for hydraulic pumps; cams and pawls for farm machinery; power transmission gears for heavy electrical appliances, including home laundry equipment. • New possibilities for your products are presented by Keystone high strength powder metallurgy. Why not review your requirements now, and call us in for consultation?

Write for our latest publication on Powdered metal production materials — free on request.



Keystone
CARBON
COMPANY
POWDERED METALS DIVISION
ST. MARYS, PA.

There's a BOWER TAPERED ROLLER BEARING engineered to fit your product



Types and sizes to fit a wide range of tapered bearing applications

There's no need to compromise with bearings! Whatever your product, if it uses tapered roller bearings, call in a Bower engineer for expert help on selecting the exact type and size you need.

Depending on your own particular needs, he'll make sure you get the exact size and type—selected from Bower's complete tapered line—engineered to assure maximum performance in your application.

Most important of all, when you specify Bower tapered roller bearings for your product, you get all the advantages of advanced Spher-O-Honed design—less maintenance, longer life, smoother operation. Get the full facts on the *complete* Bower line.

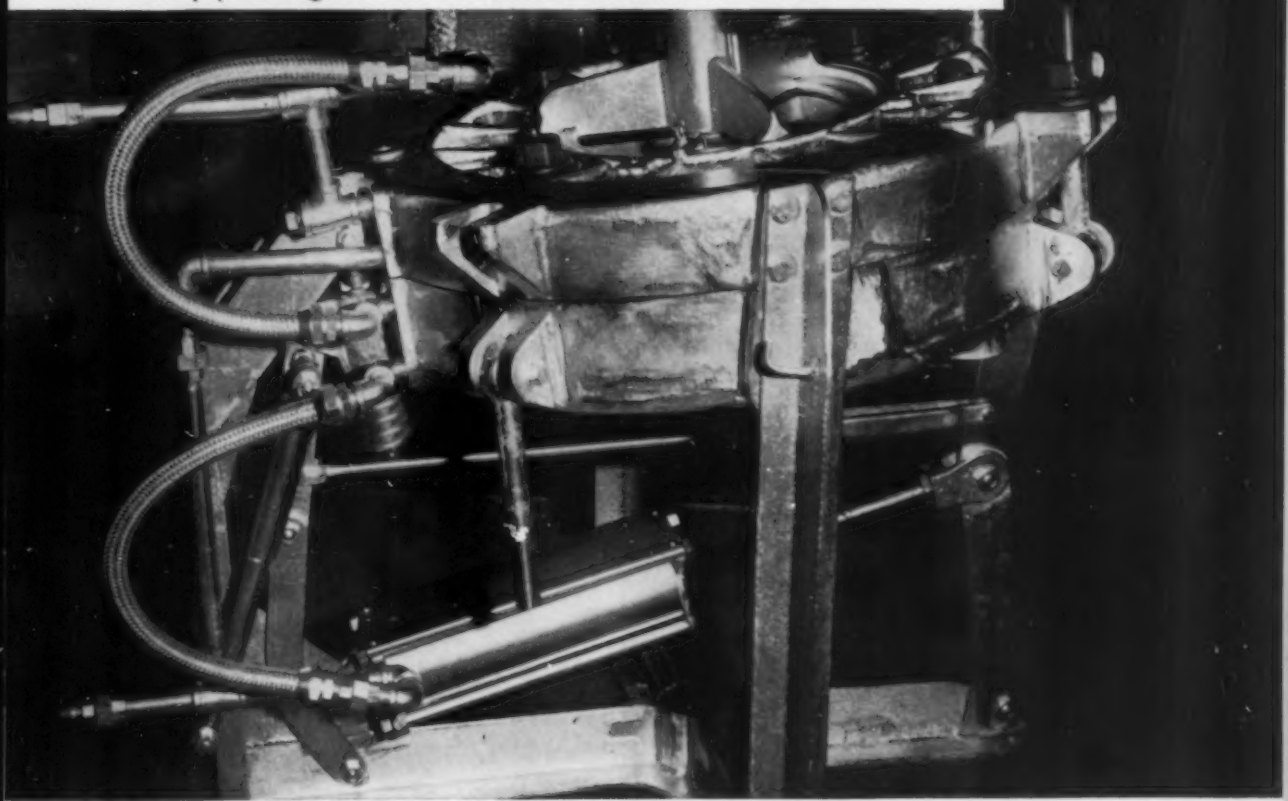
Tapered, Straight and Journal Roller Bearings for every field of transportation and industry

BOWER ROLLER BEARINGS

BOWER ROLLER BEARING DIVISION • FEDERAL-MOGUL-BOWER BEARINGS, INC., DETROIT 14, MICH.

Where your problem is pipe that must flex

reduce pipe fatigue with American flexible metal hose



300°F, 50 lb. pressure is met by American Flexible Bronze Hose connecting moving steam chambers on Super Mold tire capping equipment.

"American flexible metal hose is tops for trouble-free service!" says C. R. Lohr of the Super Mold Corporation. Since 1940, American flexible metal hose has been conveying steam between moving parts on Super Mold tire capping equipment.

Whether frequency of flexure is a few times a week . . . or a thousand times an hour . . . you'll find American flexible metal hose is tight, safe, long lasting, easy to install. In field and laboratory tests American flexible metal hose has flexed millions of times without sign of failure.

Problems Solved by American Flexible Metal Hose

American flexible metal hose absorbs vibration and prevents its transmission to surrounding structures . . . absorbs expansion and contraction in lines due to temperature changes . . . facilitates installation especially in cramped spaces . . . solves the problem of misalignment.

Available in wide range of diameters in tough bronze, steel, super nickel, brass, stainless steel and other metals. American hose, complete with fittings, is made to your specifications and ready for immediate installation.

Consult your nearby American Metal Hose representative for engineering help when planning your next job. No obligation. See American Brass Company or Anaconda in your phone book – or write: American Metal Hose Division, American Brass Company, Waterbury 20, Conn. In Canada: The Canadian Fairbanks-Morse Co., Limited.

56181

WHEREVER CONNECTORS MUST MOVE **AMERICAN**

flexible metal hose and tubing

AN **ANACONDA**® PRODUCT

Contact American to solve problems of . . .

MISALIGNMENT

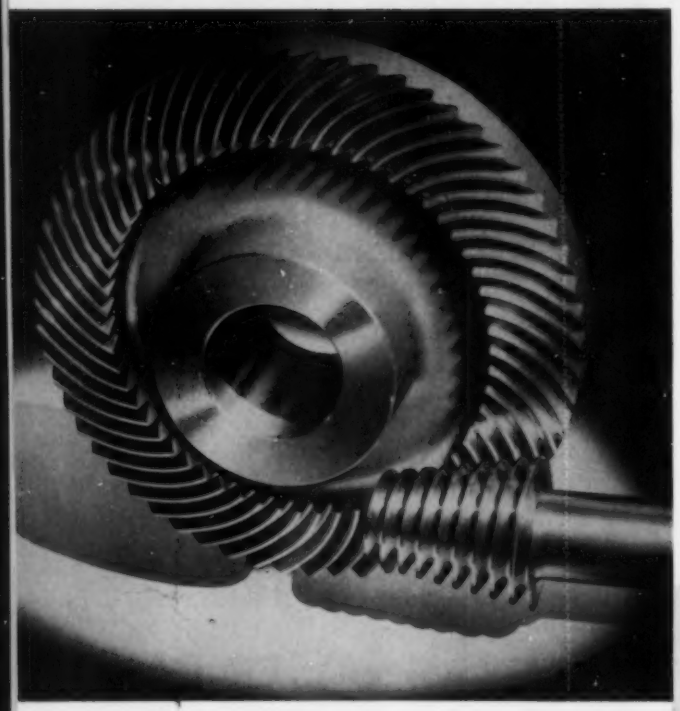
VIBRATION

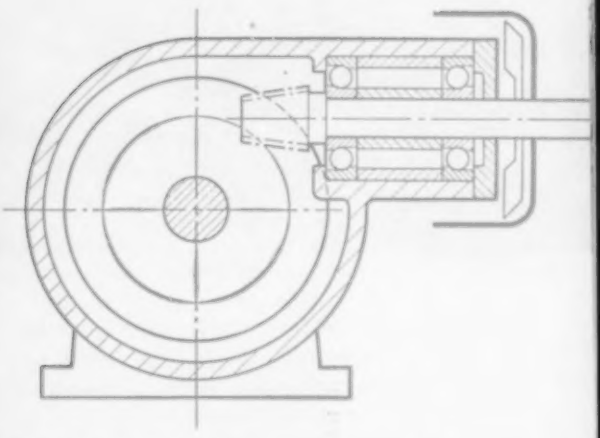
CRAMPED SPACES

MOVEMENT

Why are Spiroid Gears so successful where compactness is vital? Spiroid Gears pack more power transmission capacity per inch diameter than worm gears. Spiroid Gears are smaller, stronger, more shock resistant and more efficient . . . giving you increased gear economy, greater gear versatility, high product performance standards!

put more profit in



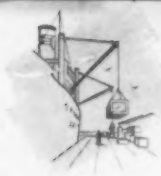


Spiroid Gears are manufactured by conventional methods or can be sintered, die cast or molded in a variety of metals and plastics. Size and weight savings are truly remarkable.

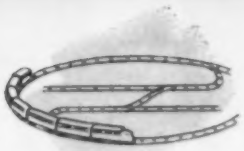
Ratios 9:1 to 300:1

Any Size

GEARMOTORS



HOISTS and WINCHES



TOY TRAINS

ELECTRIC MIXERS

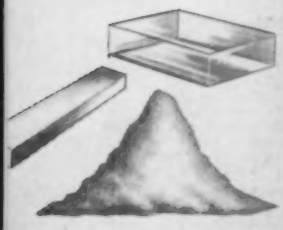
POWER SEATS

your product

with SPIROID® GEARS

Any reduction in the size of your product reduces production costs . . . giving you a larger profit margin. Spiroid Gears do just this. A completely unique design principle permits much shorter center distance between shafts . . . increases load carrying capacity. The result: smaller, lighter geared mechanisms. For example, a ⅓ HP. 30:1 gearmotor can be made with nearly 30% less space and weight! Spiroid Gears offer almost unlimited design opportunities in many other ways, too. Investigate them now . . . to put more profit in your product!

SPIROID GEAR DIVISION
2501 N. Keeler Avenue
Chicago 39, Illinois



Any Material

ILLINOIS

TOOL WORKS

SEND FOR THIS NEW BOOKLET
"More Power from Less Space" shows exactly how Spiroid Gears can put more profit in your product. Write for your copy today!

FOR COMPLEX FABRICATION. In chemical plants, these Stainless Steel acid catchers are used to remove dilute sulfuric acid from gases. Continental Boiler & Sheet Iron Works in St. Louis fabricated the units. Notice the complicated curves in the helix plates, and the neat joinery . . . a tribute to fine craftsmanship and the workability of Stainless Steel.

FOR ABRASION AND CORROSION RESISTANCE. Oil can racks stand out in all kinds of weather, and the support strips are constantly rubbed and knocked by the heavy cans of oil. Modern Metal Products Company of Greensboro, N. C. makes the strips out of Stainless Steel so they will stay bright and new-looking, and never get banged out of shape.

NOTHING *can equal* *Stainless Steel*

In its combination of desirable properties

No other design material can match Stainless Steel in its combination of desirable properties: corrosion resistance, strength and hardness, beauty, cleanability and easy fabrication. When seeking a source of supply, remember that United States Steel offers you the widest range of types, finishes and sizes.

FOR SANITATION. These Stainless Steel shelves are made by the Eastern Steel Rack Company, Boston, Massachusetts, for use in cold storage rooms. They are easy to clean, and offer a sanitary, corrosion-resistant surface for food products of all kinds.

UNITED STATES STEEL CORPORATION, PITTSBURGH • AMERICAN STEEL & WIRE DIVISION, CLEVELAND
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO • NATIONAL TUBE DIVISION, PITTSBURGH
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA.
UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS STAINLESS STEEL

SHEETS • STRIP • PLATES • BARS • BILLETS
PIPE • TUBES • WIRE • SPECIAL SECTIONS

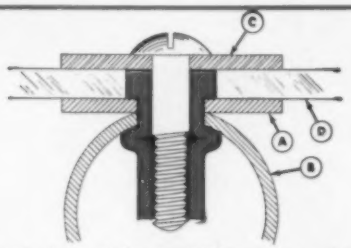
USS

UNITED STATES STEEL

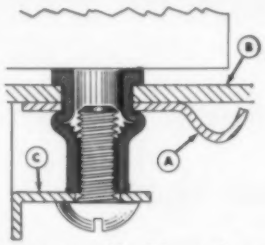
B.F. Goodrich Rivnut

cuts fastening time, saves money by doing two jobs in one operation!

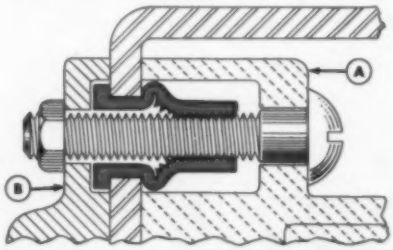
Do you have dual fastening problems like these?



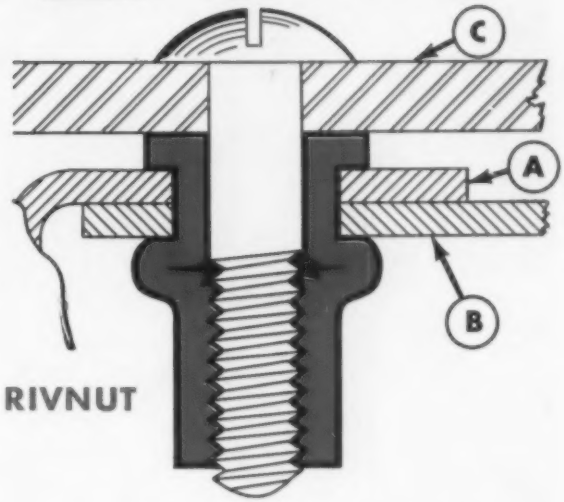
In airplane window seal, Rivnut rivets plate (A) to center post (B), provides nut plate to hold clamp strip (C). Rivnut head serves as spacer for transparent plastic sheets (D). Result: a neat, weather-tight seal!



In vaporizer assembly, Rivnut rivets upper flange (A) to casing (B), makes firm, accurate nut plate for attachment to lower flange (C). Rivnut eliminates reinforcing plate. Result: less assembly time, fewer parts, better product.



Rivnut provides 6-thread nut plate for attachment from either end—or *both*. In spotlight assembly, Rivnut replaces awkward welded stud for attaching socket (A). Plug base (B) is attached on other side. Result: fewer operations, lower assembly cost.



B. F. GOODRICH RIVNUTS cut costs and speed assembly because they rivet two parts together, make a firm, accurate nut plate for a third. And they do both jobs in one quick operation! Rivnuts can be installed from one side, take an attachment bolt from either end. They eliminate welding, tapping, clinching.

In the transformer assembly above, one worker fastens the metal cover (A) to the Glastic* sheet (B) with Rivnuts in seconds. Rivnuts then serve as mounting lugs for attaching completed transformer to mounting plate (C).

B. F. Goodrich Rivnuts have speeded up thousands of fastening jobs—can do the same for you.

SEND NOW FOR FREE RIVNUT DEMONSTRATOR

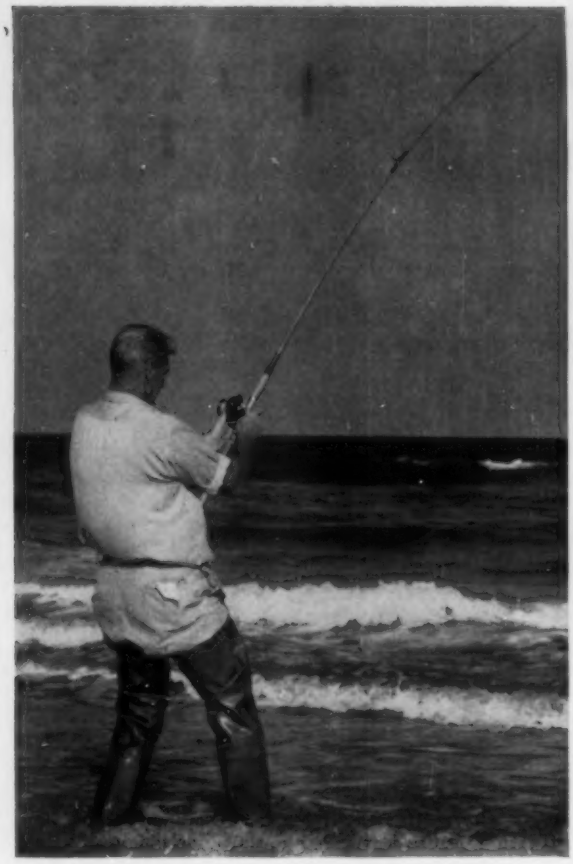
Demonstrates with motion how you can use Rivnuts to fasten WITH and TO. Explains construction, simplicity of installation. Get your free copy today by writing to: B. F. Goodrich Rivnuts, Dept. PE-126, Akron, Ohio.

*T. M. Reg. The Glastic Corp.

B.F.Goodrich

AVIATION PRODUCTS

a division of The B. F. Goodrich Company, Akron, Ohio



Carpenter Free-Machining Stainless eliminates expensive handwork on fishing reel shaft

Excessive burrs when machining this level wind shaft for a fishing reel were constantly interfering with maximum productivity. Other important factors on the job are good corrosion resistance, and long wearing qualities.

Seeking improvement not only in the product, but also in its manufacture, the company decided to try Carpenter Stainless No. 5 (Type 416). The results were exactly as anticipated . . . easier, more uniform machining properties and burr-free finishes took the job out of the doubtful class and made it a profitable operation. No. 5 eliminated expensive hand work on the shaft, and put this job on a profitable, productive basis.

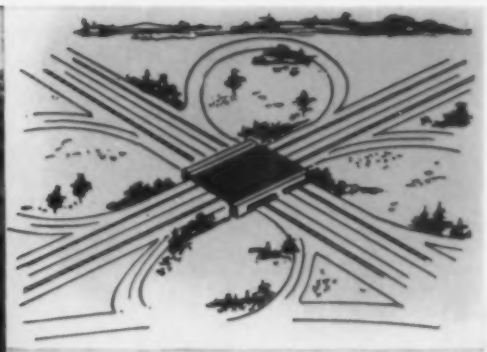
If you're not now using Carpenter Free-Machining Stainless, here's a real opportunity to improve production of stainless parts and products. For immediate delivery, call your nearest Carpenter Mill-Branch Warehouse, Office or Distributor.

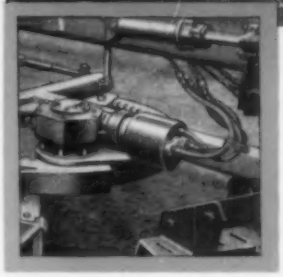
Carpenter STEEL

Free-Machining Stainless Steels

The Carpenter Steel Company, 117 W. Bern St., Reading, Pa.

Export Dept.: The Carpenter Steel Co., Port Washington, N. Y.—"CARSTEELCO"





GALION 104 Motor Grader, above, uses Eastman Assemblies on *EIGHT* Hydraulic controls for more accurate, effortless and economical grading. Close-up, left, shows powerful Hydraulic Circle Turn for famous Galion "Reversible" Moldboard.

BARBER-GREENE Bituminous Finisher, right, automatically lays level finish for smoother, safer travel. Close-up shows Eastman Hydraulic Hose Assembly delivering 2,700 lbs. pressure to raise and lower finishing screed.

Smoother, Safer Roads

BUILT WITH HYDRAULIC POWER

DELIVERED THROUGH

Eastman

HYDRAULIC HOSE ASSEMBLIES

ALWAYS SPECIFY

EASTMAN Pressed-on, Reusable and Renewable Couplings for high and low pressure air, gas, water, paint, grease and hydraulic fluids. Eastman Straight and Angled Adapter Unions.

Smoother, safer highways are being built today through the application of modern engineering and the use of modern equipment—much of which is hydraulically operated—using Eastman Hydraulic Hose Assemblies.

GALION—pioneer builder of road machinery—whose Motor Graders and Rollers are used 'round the world—first used hydraulic controls as early as 1927. Eastman Mfg. Co. pioneered in the development of Hydraulic Hose Assemblies in 1926—and *Galion is Eastman equipped today!*

BARBER-GREENE—whose Bituminous Road Finishers have been used at one time or another on almost every road ever built—also uses Eastman Hydraulic Hose Assemblies. Hydraulic power is used to raise and lower the all-important mechanism which lays a level finish—regardless of irregularities in the base. Barber-Greene's founding date of 1916 closely parallels Eastman's of 1914—and *Barber-Greene is Eastman equipped today!*

EASTMAN—*first in the field*—is proud to have pioneers such as Galion and Barber-Greene—as well as many other leading American manufacturers—use Eastman Hydraulic Hose Assemblies. Look to Eastman for *continued leadership* in engineering and design for quality of material and workmanship—plus better-than-ever service through expanded production facilities of our new, modern plant.

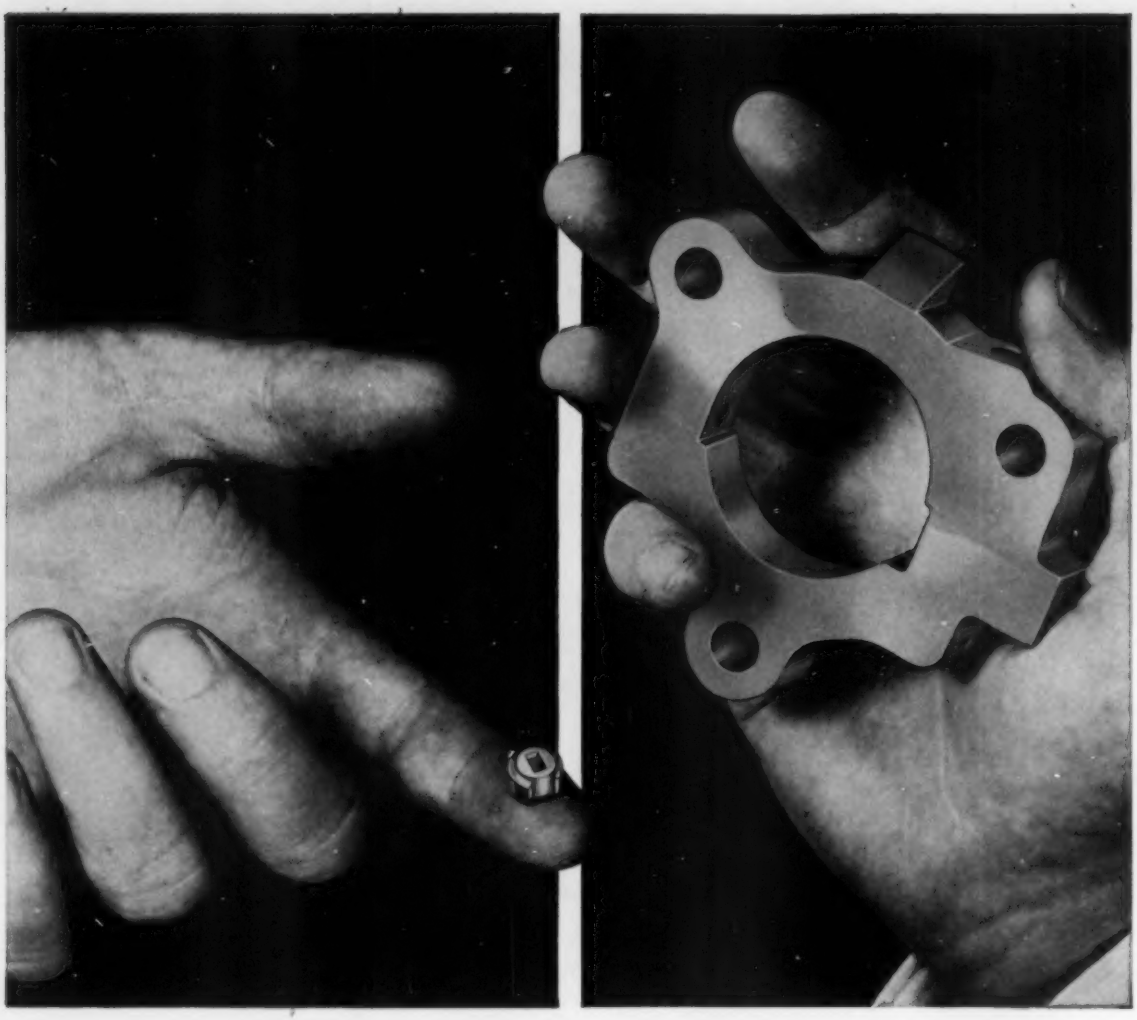
SAFEGUARDING INDUSTRY'S Lifetime Mobile Power

Eastman
first in the field
MANUFACTURING COMPANY
Dept. PE12, Manitowoc, Wis.

BUILD BETTER ROADS TODAY · FOR A GREATER AMERICA

See you at the ROAD SHOW CHICAGO Jan. 28-Feb. 2, 1957

BOOTH NO. 359—SECTION A
(North Hall, 2nd floor)



Does part *size* limit use of metal powder?

Everything has limits. But the illustrations above will give you some idea of the wide range of part sizes easily produced from metal powder.

Often a single press operation will replace many machining operations, yet the finished part comes off the line more accurately made in every detail.

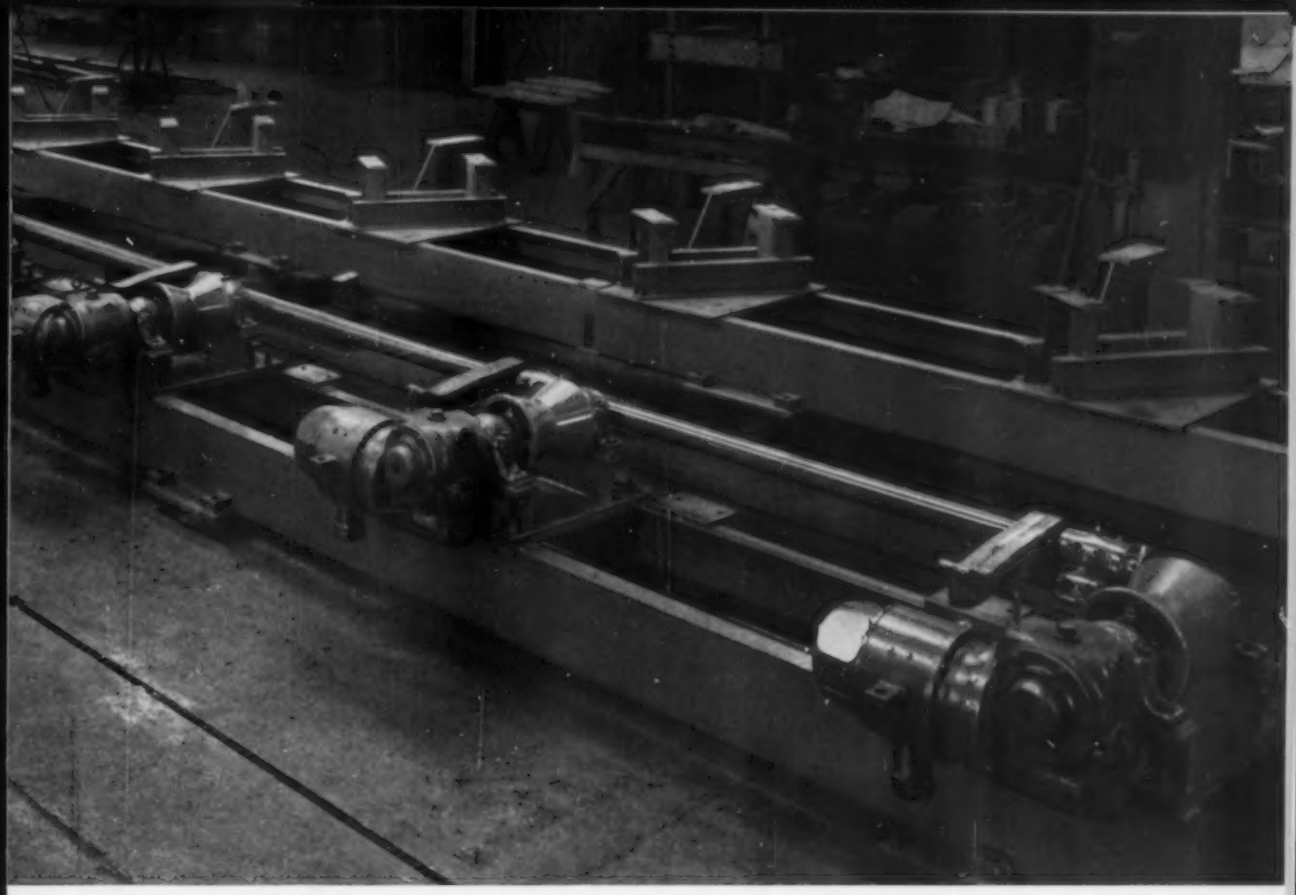
Moraine Products has the experience gained from the production of hundreds of millions of metal powder parts in an infinite variety of shapes and sizes. This experience and our familiarity with other types of metal working processes, guide our engineers in determining whether our materials and our processes are best suited to the production of a specific part.

When we accept a job to make metal powder parts, it is only after thorough study has shown that the customer will receive parts of the highest uniform quality for dependable end-product performance. Of course, on-time delivery is assured, regardless of quantity.

Moraine Products also produces: Moraine Power Brakes—Delco hydraulic brake fluids, brake assemblies, master cylinders, wheel cylinders, and parts—Moraine friction materials—Moraine-400 and M-100 automotive engine bearings—self-lubricating bearings and porous metal filters—rolled bronze and bi-metal bushings.

Another General Motors Value

Moraine Products
Division of General Motors, Dayton, Ohio



FACT: New floating roll-table drive solves space, shock, maintenance problems

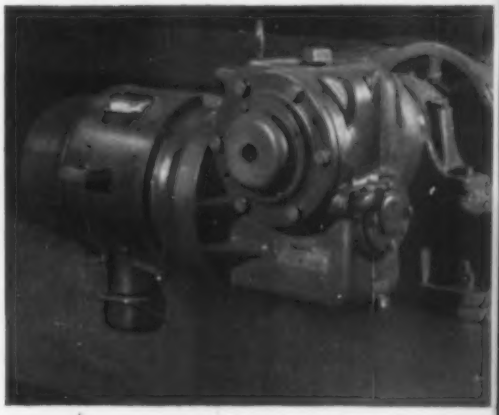
Basic facts show how Westinghouse floating gearmotors bring greater efficiency and economy to roll-type conveyor operations:

FACT 1: Space needs minimized by compact drive design
Shaft suspension of drive and absence of separate coupling give maximum spacesaving and assure greater operating safety.

FACT 2: Roll shocks cushioned by spring mounting
Spring mechanism on anchor arm and "on-shaft" mounting enable this gearmotor to withstand shocks and stresses from roll eccentricity.

FACT 3: Maintenance reduced by drive simplicity
Absence of couplings, simple yet rugged gear arrangement and integral design of over-all unit all combine to cut maintenance needs to the minimum.

For more facts on this or any Westinghouse gearing equipment, call *The Man With The Facts*. . . : he's the Westinghouse sales engineer at your nearest Westinghouse sales office! J-07343

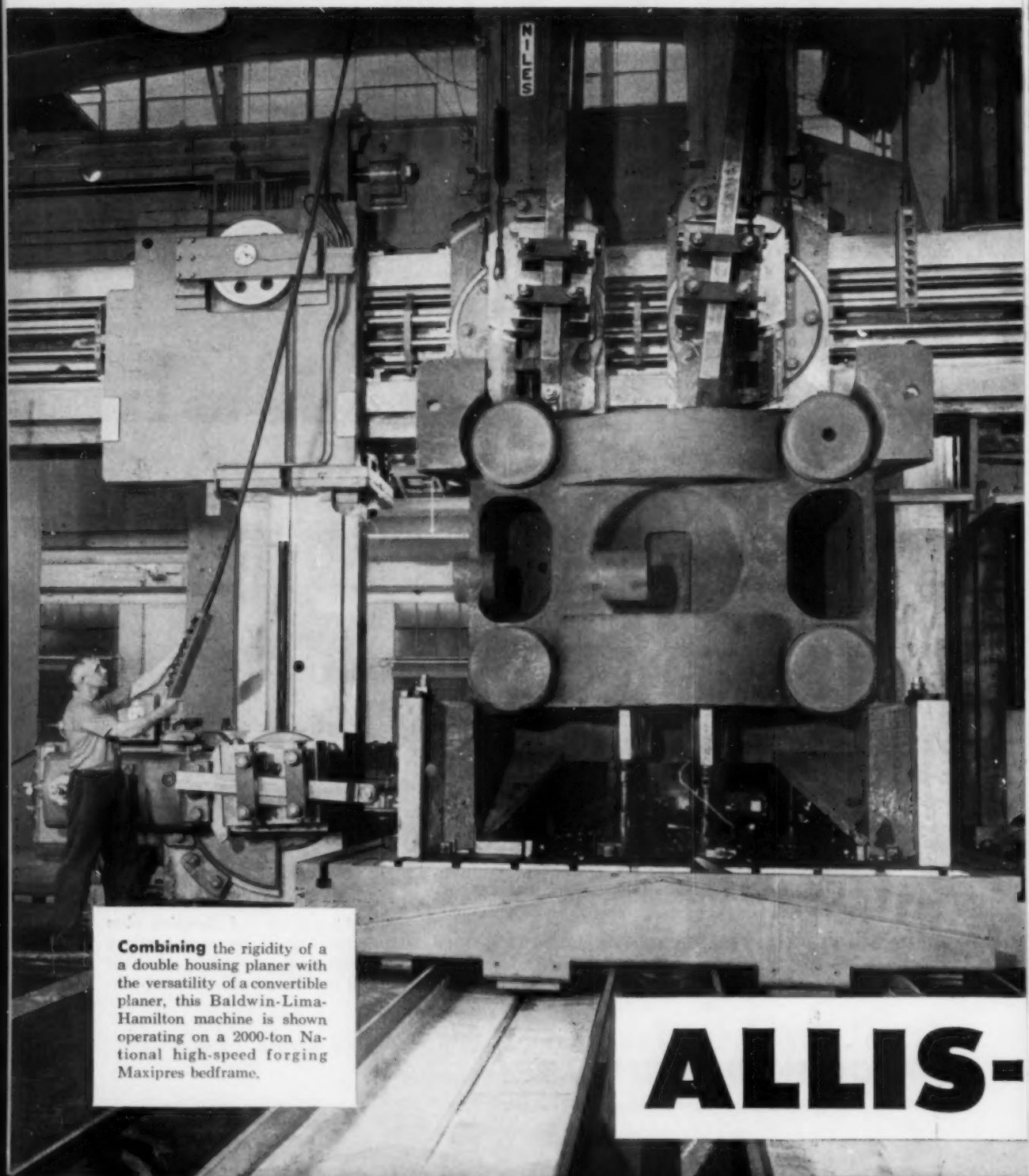


A locking screw and clamping plate lock this compact gearmotor firmly to roll-table shaft. All power is transferred to roll shaft at low unit pressures.

WATCH WESTINGHOUSE!

WHERE **BIG** THINGS ARE HAPPENING **TODAY!**

Allis-Chalmers DC MOTOR and Drive Giant



Combining the rigidity of a a double housing planer with the versatility of a convertible planer, this Baldwin-Lima-Hamilton machine is shown operating on a 2000-ton National high-speed forging Maxipres bedframe.

ALLIS-

CONTROL...

New Planer

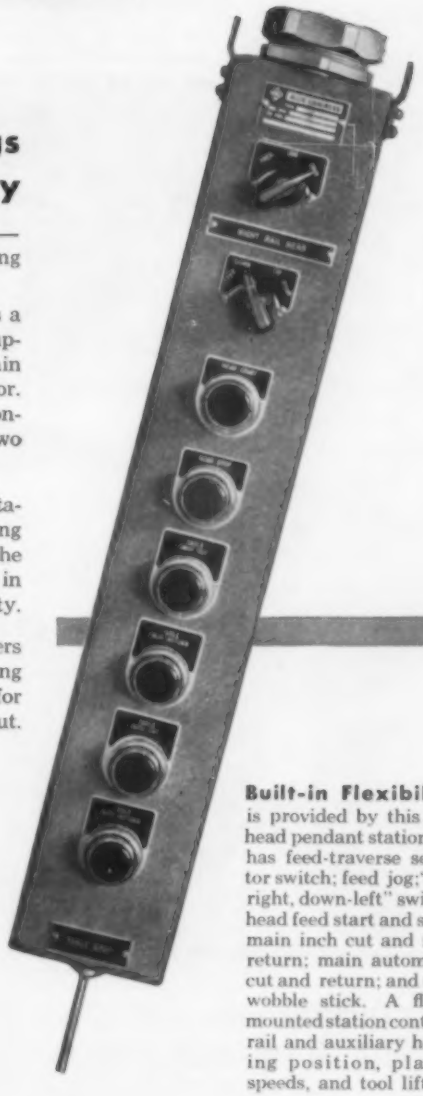
Baldwin-Lima-Hamilton NILES Planer Handles Flatcar-Size Castings in One Setup at National Machinery

Reduced machining time . . . single setup . . . one-man control — all are advantages of this huge planer which handles any casting within the size dimensions of a railroad flatcar shipment.

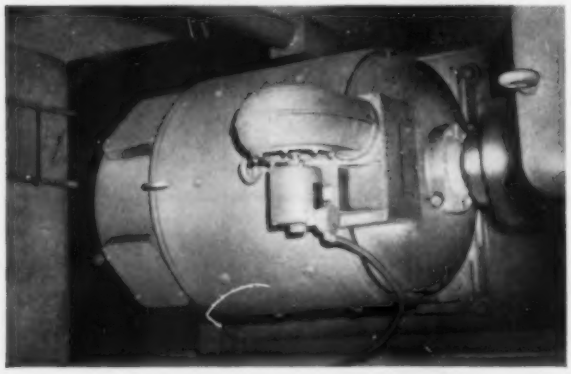
Giving the giant machine maximum flexibility and speed is a specially engineered combination of Allis-Chalmers motors, supporting motor-generator set, *Regulex* exciter, and control. Main power is supplied by a 100-hp, variable-voltage reversing motor. This motor and the auxiliary ac motors are coordinated by controls which can be operated from several locations, including two pendant stations.

Single-Handed Positioning — The pendant control stations and other stations permit the operator to position for planing and make all adjustments without help. From one location he may adjust both the left-hand auxiliary housing and planing, in addition to other functions. This gives the machine great flexibility.

On-the-Job Insurance — Every part of the Allis-Chalmers drive motors, from long-lasting field coils to thorough ventilating system, is built to eliminate costly shutdowns. It's designed for heavy duty . . . handles extra-tough cuts with no chance of burnout.



Built-in Flexibility is provided by this rail head pendant station. It has feed-traverse selector switch; feed jog; "up-right, down-left" switch; head feed start and stop; main inch cut and inch return; main automatic cut and return; and stop wobble stick. A floor-mounted station controls rail and auxiliary housing position, planer speeds, and tool lifting.



Sturdy Construction is a prime feature of this Allis-Chalmers 100-hp, dc drive motor. Located in a deep pit below the planer, its rigid design holds bearing alignment true — keeps grease in, foreign particles out.

There's a right combination of Allis-Chalmers motors and control for your application, too. Contact your nearby Allis-Chalmers sales office or write Allis-Chalmers, General Products Division, Milwaukee 1, Wis.

CHALMERS

A-C ALLIS-CHALMERS

A-5039

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Waterbury Manufacturing Company Division
236 McNamara Street, Waterbury 20, Conn.

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PLEASE SEND ME YOUR THREE-DIMENSIONAL BOOKLET ON NON-FERROUS FORGINGS, COMPLETE WITH VIEWING GLASSES. I want to see for myself how forgings by Chase can give me economical parts that have higher tensile strength, smoother surfaces and require less machining and finishing.

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Get *stronger*, more efficient and attractive parts that are completely interchangeable with absolute minimum hand fitting! Find out about non-ferrous forgings by Chase, blank or machined and polished and plated if desired. Send the coupon above, today!

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WATERBURY 20, CONNECTICUT

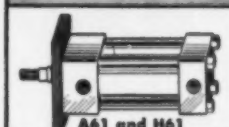
over 8,000 Different Cylinder SELECTIONS—

Miller AIR AND HYDRAULIC CYLINDERS AND BOOSTERS "IN STOCK" for immediate delivery

See Miller Bulletins A-105K(Air) and H-104K(Hydraulic) for Complete Dimensions and Engineering Data on these "in-stock" sizes and other Custom Miller Cylinders in bores up to 20" and strokes up to 22 feet.

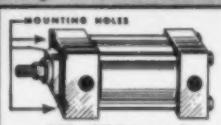
"IN-STOCK" MODELS

"A" Signifies Miller 200 psi Air Cylinders; "H", 2000 psi Hydraulic Cylinders. Interchangeable Mountings Are Shown In Rod On Drawings.



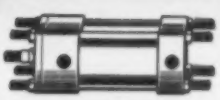
A61 and H61
Flange Mounting on Rod End
(A61 not available in 8" bore)

A62 and H62
Flange Mounting on Cap End
(A62 not available in 8" bore)

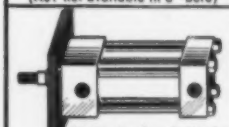


A63—8" Bore only
Flange Mounting on Rod End

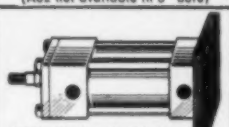
A64—8" Bore only
Flange Mounting on Cap End



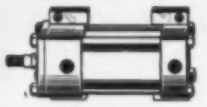
A50 & H50—Tie Rods not extended beyond nuts.
A51 & H51—Tie Rods extended both ends (shown).
A52 & H52—Tie Rods extended. Cap End only.
A53 & H53—Tie Rods Extended. Rod End only.
A54 & H54—Two Tie Rods extended at both ends.



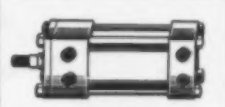
H65—Hydraulic Only
Flange Mounting on Rod End



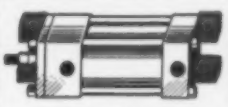
H66—Hydraulic Only
Flange Mounting on Cap End



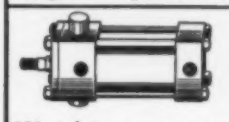
A72 and H72
Side Lug Mounting



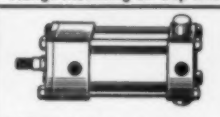
A74 and H74
Side Flush Mounting



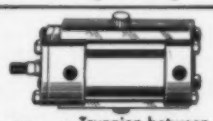
A77 and H77
Side or Foot Mounting



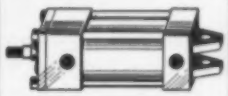
A81 and H81 Trunnion Mounting on Rod End



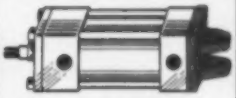
A82 and H82 Trunnion Mounting on Cap End



A83 and H83 Trunnion between Head and Cap
(one week delivery)



A84 and H84
Pivot Mounting



A86 and H86
Pivot Mounting

IN STOCK BORES in Inches

"IN-STOCK" STROKES (in Inches)

	BORES	ROD DIA.	ROD TURN DOWN & THREADS		1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
AIR	1½	⅝"	7/16-20	Cushioned			3	4	5	6	7	8	9	10	11	12									
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12									
	2	⅝"	7/16-20	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	2½	⅝"	7/16-20	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	3¼	1"	¾-16	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	4	1"	¾-16	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	5	1"	¾-16	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	6	1⅜"	1-14	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	8	1⅜"	1-14	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
HYDRAULIC	1½	⅝"	7/16-20	Cushioned			3	4	5	6	7	8	9	10	11	12									
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12									
	2	1"	¾-16	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	2½	1"	¾-16	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	3¼	1⅜"	1-14	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	4	1¾"	1¼-12	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	5	2"	1½-12	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36

(1) "A" and "H" Models 82, 84 and 86 with strokes over 18" require stop tubes.

Column strength requires larger diameter piston rods for the following:

Air Cylinder Models A82, 84, and 86 with strokes inside area (1), when operated at 100 psi and over;

All hydraulic models with strokes inside area (2) and Models H82, 84, and 86 with strokes in area (4), when operated at 2000 psi and over;

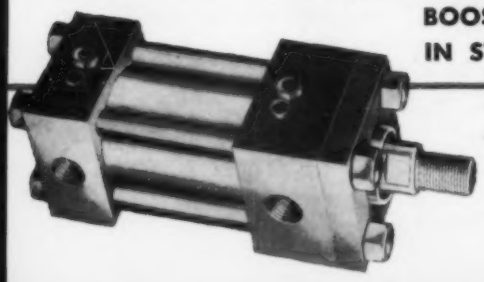
(4) Models H82, 84 and 86 with strokes inside area (3), when operated at 1000 psi and over.

Depending upon Trunnion Pin location, "A" and "H" Models 83 with standard diameter piston rods can have longer strokes than Models 82, 84 and 86.

See Miller File #251 for oversize piston rod and stop tube requirements.

BOOSTERS IN STOCK

Immediate Delivery on the following Miller 25 to 1 Ratio Boosters (80 psi air input produces 2000 psi hydraulic oil output): Model B4, 5" bore, 1" dia. ram, 6" and 12" strokes; Reciprocating Booster Model DA77-RBA8, 5" bore, 1" dia. ram, 6" stroke. Also Booster Tanks, 5" dia., 6" and 10" heights.



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Miller

MILLER FLUID POWER DIVISION
FLICK-REEDY CORP.

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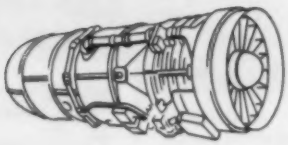
AIR & HYDRAULIC CYLINDERS • BOOSTERS • ACCUMULATORS
COUNTERBALANCE CYLINDERS

You get extra WEAR RESISTANCE



with

Flame-Plating

by Linde Trade-Mark

Flame-Plating – a remarkable detonation process – is now being used to coat metal parts with a thin coating of tungsten carbide or aluminum oxide. Results from experience with parts in actual use show that Flame-Plating solves many problems of wear, abrasion, and fretting corrosion.

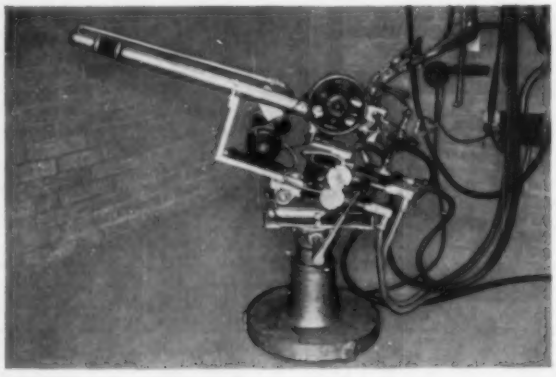
The temperature of the part being coated seldom exceeds 400-deg. F. Precision parts can therefore be Flame-Plated without risk of changes in their metallurgical properties or physical dimensions. Practically all metals can be Flame-Plated–steel, copper, aluminum, magnesium, molybdenum, titanium. Coatings of tungsten carbide and aluminum oxide can be Flame-Plated in thicknesses from .002 to .010 inch, and finished to 0.5 microinches rms.

Flame-Plating applications have been proved in service. Parts for aircraft and rocket power plants, hydraulic systems, and heating units, as well as various types of plug and ring gages, bearings and seals, and dies have had their useful lives considerably extended–economically–by Flame-Plating.

Find out how Flame-Plating can help to improve your own product. Request a copy of the free booklet, "Flame-Plating," F8065. Address "Flame-Plating, Department P-12."

FLP Service Mark

The Flame-Plating gun consists mainly of a barrel and a mechanism for loading precise amounts of powder and gases into a firing chamber. The powder remains suspended in the explosive gases until a spark ignites the mixture, producing heat and pressure waves of tremendous force. The molten particles are hurled with supersonic velocity against the workpiece where they fuse and build up until the desired thickness is obtained.



The term "Linde" is a trade-mark, and FLP is a service-mark of Union Carbide and Carbon Corporation.

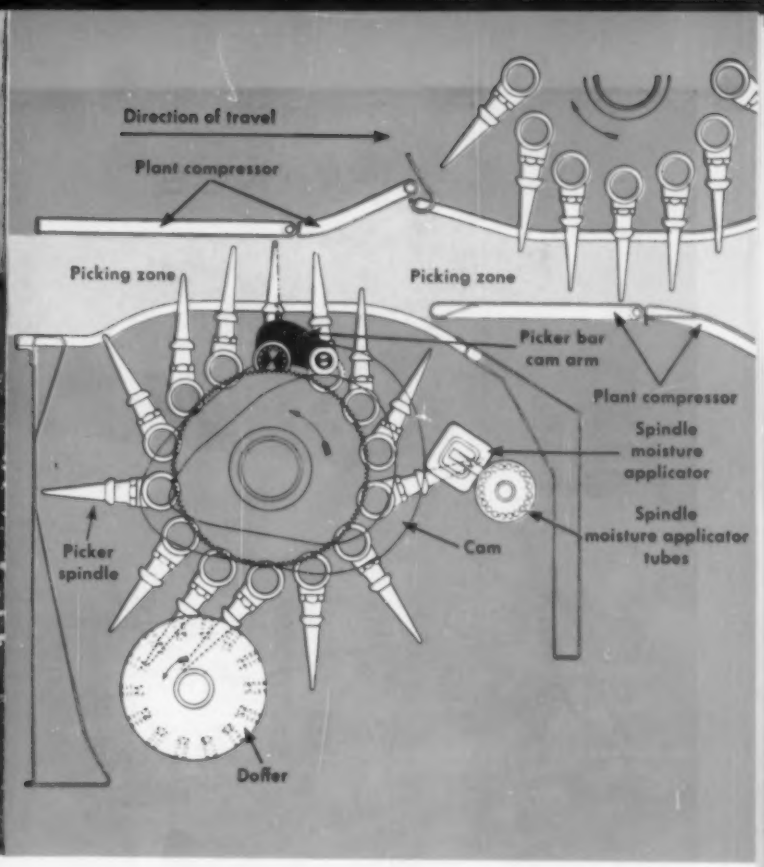
LINDE AIR PRODUCTS COMPANY

A Division of Union Carbide and Carbon Corporation

30 East 42nd Street UCC New York 17, New York

In Canada: Linde Air Products Company, Division of Union Carbide Canada Limited, Toronto

Flame-Plating by Linde



How angular power transmission makes still another improved design practical

This cotton picking machine is just one of many, many products improved and made more practical through the flexibility of angular power transmission.

Using the angle of transmission shown at right, the makers of the machine can put a whole roll of spindles on a bar and drive them with a single source. The spindles pluck bolls gently from the cotton plant and deliver them unmarred to a collecting basket.

Besides this flexibility, bevel gear transmissions usually weigh less, cost less, and carry heavier loads.

Our engineers are ready at all times to help you work out applications for bevel and hypoid gears.

They can discuss such items as mountings and lubrication. They can produce and test prototypes of your drives.

Finally, they can advise you on the proper machinery to use to produce top quality gears in large quantities at low costs.

Please write whenever you have an application in mind.

Meanwhile, you'll find these Gleason Technical Handbooks helpful:

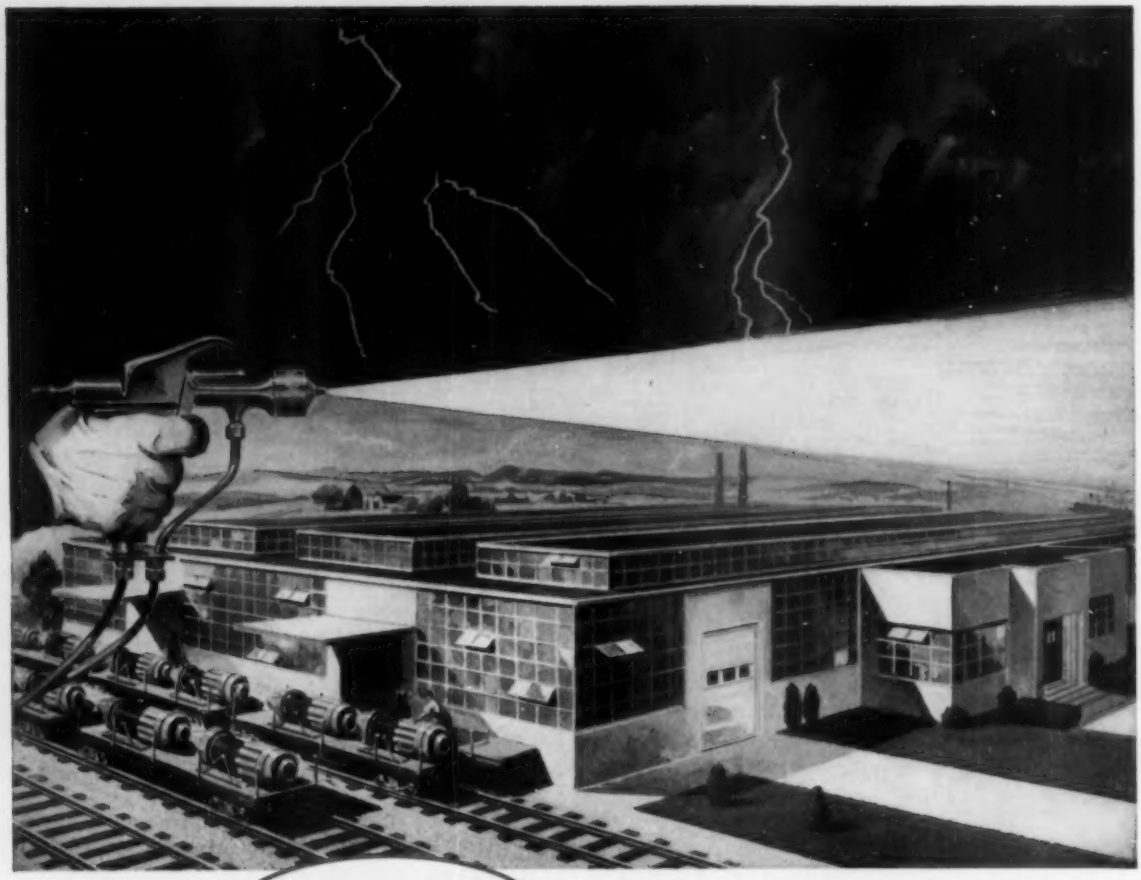
20° straight bevel gear system
Spiral bevel gear system
Zerol® bevel system

The cotton picking machine shown above, uses 420 of these tapered spindles in its picking drum (diagram). The machine slashes picking costs by as much as 60%.

GLEASON WORKS

Builders of bevel gear machinery for over 90 years

1000 UNIVERSITY AVE., ROCHESTER 3, N. Y.



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To wipe out corrosion by weather, rust and rot, industry looks to the performance and versatility of the 6 specifically-engineered Firestone Exon solution resins.

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Each of the 6 Exon solution resins is engineered for a specific type of application. It may protect a product, a part, a roomful of machinery or the outside of a plant. Some feature so powerful an adhesive grip that they hold fast for many damage-free years. Others are made to peel off clean in seconds.

All are tough, economical vinyl resins that can help save billions of dollars that management once passed off as "necessary depreciation" due to corrosion. They are a few of the many resins in Firestone's complete line of versatile vinyls. Another reason why industry looks to Exon for engineered answers to its needs.

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EXON

VERSATILE VINYL RESINS
engineered answers to industry's needs

Firestone Plastics Co. supplies only the resins, does not make the finished solutions.

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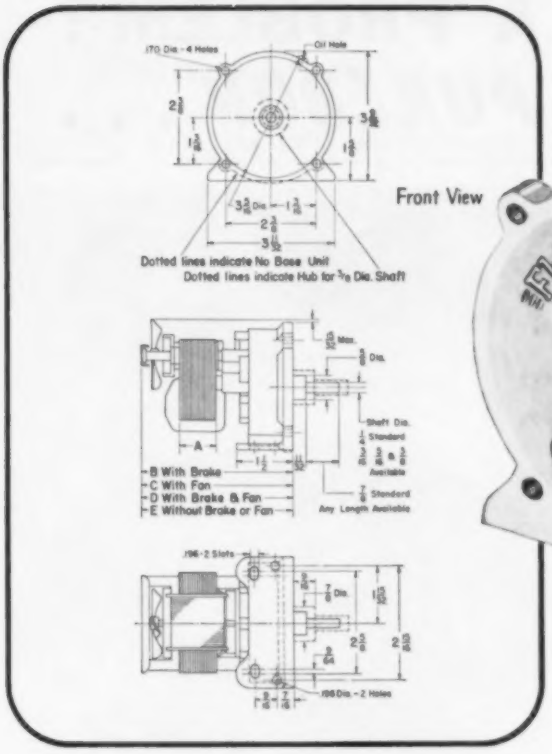
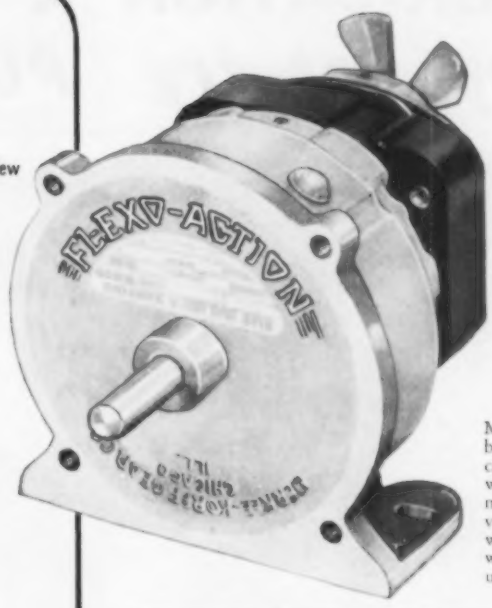

Front View
Dotted lines indicate No Base Unit
Dotted lines indicate Hub for 3/8 Dia. Shaft
B With Brake
C With Fan
D With Brake & Fan
E Without Brake or Fan
Any Length Available



Model SG25 with base case. This unit can also be furnished with no base for face mounting, with inverted base, or side wall mounting, or with shaft vertically upward.

Stator Thickness and Corresponding Length				
A	B	C	D	E
9/16	3 1/8	3 1/4	3 9/16	2 7/8
1 1/16	3 1/2	3 7/8	3 1 1/16	3 1/4
1 1/2	4 7/16	4 3/4	4 1 1/16	4 1/4

How To Buy the Right Geared Motor for Your Job

Measure the speed and torque required when possible. If torque can't be measured make a realistic estimate. Buying a motor that is too strong can be just as harmful as buying one that is too weak.

Be sure to specify direction of rotation, if uni-directional, or reversing if required. Will the motor operate continuously or is the duty cycle intermittent? Specify the type motor required for the job—whether induction or synchronous, AC, DC or universal.

Experienced Merkle-Korff application engineers can assist you in choosing the right unit for the job. They will recommend a fractional horsepower geared motor with an ample margin of safety to meet overload or low voltage conditions.

Merkle-Korff has been building a product of proven quality for years and can deliver motors *on time* to fit your production schedule.

A typical torque table is shown. This table shows no-load speeds for uni-directional shaded pole induction motors. The loads are the maximum under which the motor will start and operate continuously without over-load. The speeds shown are those commonly used. If the maximum rated torque is required at speeds greater than shown, modifications can usually be made. Units can be furnished at speeds as low as 1 RPH or slower.

Merkle-Korff builds a varied line of fractional horsepower geared motors. For detailed dimension drawings, mounting styles and torque tables of the complete line, write for engineering data sheet PE2.

TORQUE TABLE - LB. IN.
MODEL SG-25

	stator thickness and torque		
rpm	9/16"	1 1/16"	1 1/2"
300	1.2	1.5	3.0
150	2.3	3.0	6.0
100	3.5	4.5	9.0
60	6.0	7.5	15.0
45	6.6	9.0	17.0
30	10.0	13.0	26.0
25	12.0	16.0	30.0*
20	15.0	20.0	"
15	20.0	26.0	"
12	25.0	30.0*	"
10	30.0	"	"

* At these speeds and lower the units will deliver more torque than is shown on the tables. The output shaft should not be loaded above the value shown on the table. This is the rated capacity of the gear case.

MERKLE-KORFF GEAR CO.

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4. Dimensionally stable — does not warp or distort at high temperatures.
5. Light weight — low cost where molded to size.
6. Low coefficient expansion — good electrical conductivity.

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New conveyor belt made with MYLAR® helps solve another industrial problem

In many plants throughout the country, abrasive, corrosive and sticky products are raising havoc with conventional conveyor belts. But thanks to a new type of conveyor belt made with "Mylar"* polyester film, firms such as S. F. Whitman Co. and Sons, Inc., Philadelphia, have extended conveyor belt life while cutting plant maintenance costs.

Where special problems exist, conveyor belts made with "Mylar" are giving excellent performance because they are:

Dimensionally Stable—"Mylar" is not affected when exposed to extremes of moisture or temperature. Service range is from −60° to 150°C.

Smooth Surfaced—"Mylar" provides excellent release for sticky substances. The surface is smooth and stays that way.

Chemically Resistant—"Mylar" resists attack by most solvents and chemicals; it's unaffected by hot oils or greases.

Strong and Durable—"Mylar", because of high tensile strength, withstands high tensions to which conveyor belts are subjected.

Clean and Sanitary—"Mylar" is unaffected by bacteria. It has no ridges or valleys to hold dirt. It's easy to clean and keep clean.

This is another example of how Du Pont "Mylar" is helping improve established products and create new ones. Whether you make guided missiles or ladies' handbags, "Mylar" may help improve performance or increase the over-all value of your product. For more information on "Mylar" or products made with "Mylar", send in coupon.

Du Pont manufactures the basic material "Mylar"—not finished conveyer belts.

*"MYLAR" is Du Pont's registered trademark for its brand of polyester film.

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POLYESTER FILM

• Products like hot, sticky doughnuts with highly abrasive sugar are rough on most conveyor belts, reports one of the nation's largest bakers. But when made with tough, durable "Mylar", belts resist abrasion—last longer.

• Plaques made with "Mylar" help S. F. Whitman Co. & Sons, Inc., achieve a smooth finish on all surfaces of their famous chocolate candies. Bacteria-resistant "Mylar" helps maintain a tradition of top quality.

In Canada, "Mylar" is sold by the Du Pont Company of Canada Limited, Films Div., P. O. Box 660, Montreal, Quebec.

E. I. du Pont de Nemours & Co. (Inc.)
Film Dept., Room P-12, Nemours Building, Wilmington 98, Delaware.

☐ Please send me names of firms who manufacture conveyor belts made with "Mylar" polyester film.

☐ Please send me information on properties, applications and types of "Mylar" available (MB-4).

Application_____

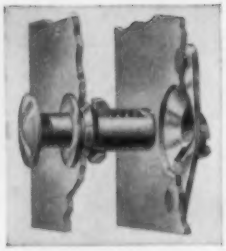
Name_____

Firm_____

Address_____

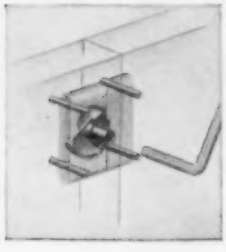
City_____ State_____

3 ways to save on assembly costs



QUICK-LOCK For fastening removable access doors and panels. Because of its ease of installation, QUICK-LOCK is ideal for assembling removable panels. A 90° turn locks it in place. Stud is self-ejecting when unlocked; visual inspection shows whether fastener is locked. Spring loading takes initial load; solid supports carry increased load. Available in a wide range of sizes.

SPRING-LOCK One-piece fastener for blind holes has load-carrying steel spring wire. Spring steel arms lock fastener securely, prevent loosening under vibration. SPRING-LOCK will work with varying panel thicknesses, locks with a twist of the wrist. Made in all-metal and plastic with steel insert. The molded design permits heads to be made in various shapes for refrigerator shelf supports, washer knobs, brackets. Available in a wide variety of shapes and sizes, and also in custom designs.



ROTO-LOCK Serrated, tapered cam is engaged by formed lug as fastener is locked. Cam action draws panels together tightly, insures locking even under conditions of misalignment. Opens easily for demounting. ROTO-LOCK carries heavy tension and shear loads; can be used for air and water-tight seals; recesses completely into panels. Solidly built without springs or delicate mechanical parts, unaffected by arctic temperatures or field service.

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SPRING-LOCK
ROTO-LOCK
LINK-LOCK
DUAL-LOCK

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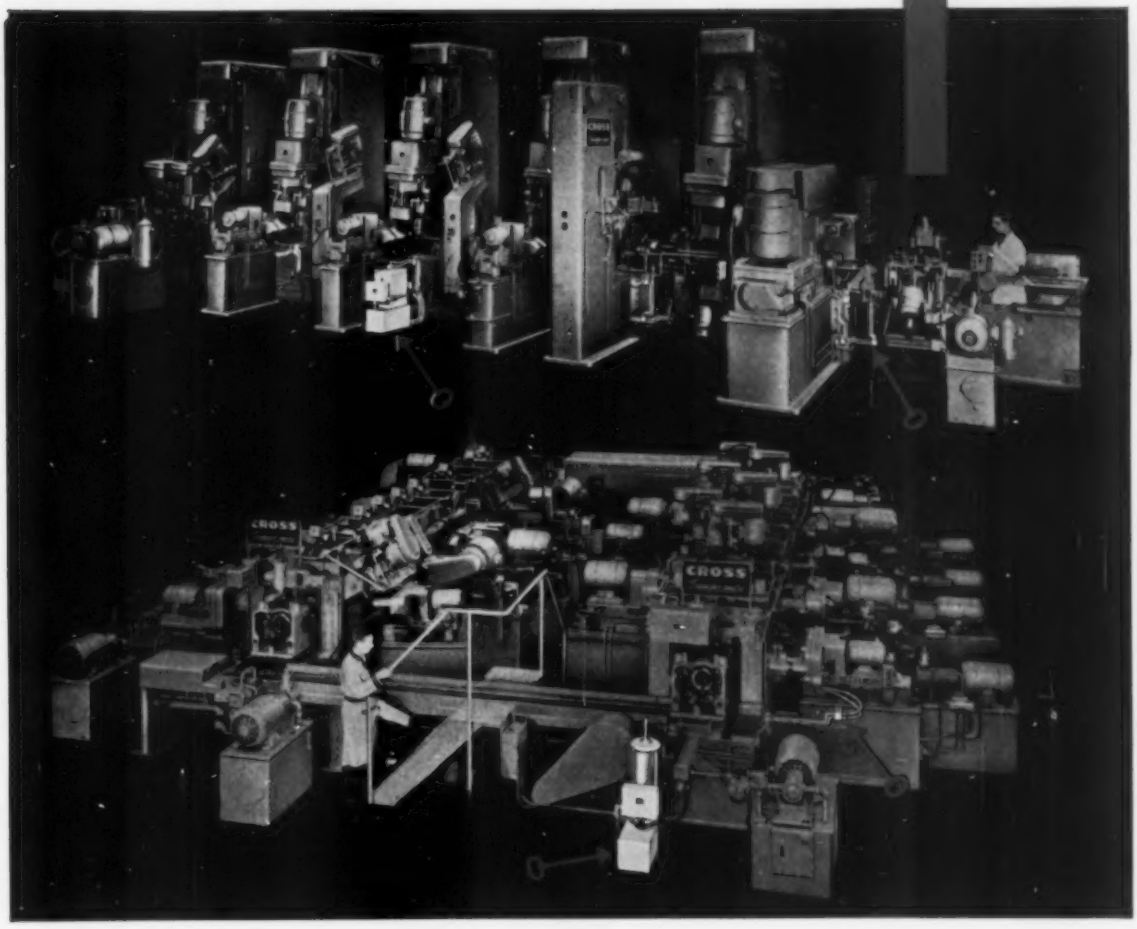
FARVAL—
Studies in Centralized Lubrication
No. 194



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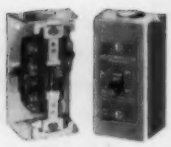
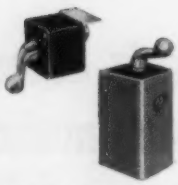


Bulletin 600 starter for motors of 1 hp or less. Overload protection

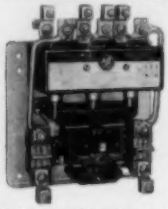
Bulletin 609 manual starters. Has overload breakers



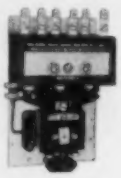
Bulletins 350-806 small rotary drum switches—all types

Bulletin 807 drum type small instrument switches

Bulletin 860 solenoids—9 sizes up to 1½ in. stroke



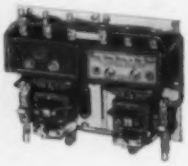
Bulletin 709 solenoid across-the-line magnetic starters



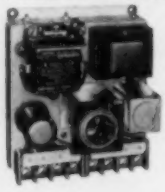
Bulletin 702 solenoid contactors up to 900 amperes

Bulletin 704 hum-free solenoid contactors with latch

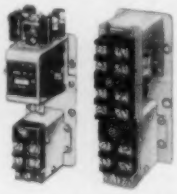
Bulletin 700 solenoid relays up to 8 poles—full line



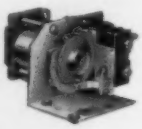
Bulletin 705 reversing starters—elec. & mech. interlocked



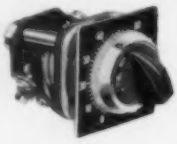
Bulletin 852 electronic timer—¼ sec to 2 minutes



Bulletin 849 pneumatic timer—⅛ sec to 3 minutes



Bulletin 850 timer—up to six reversals per minute



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Bulletin 808 plugging switch for stopping motors—no drift

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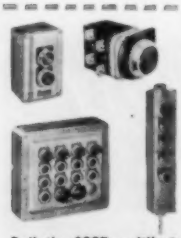
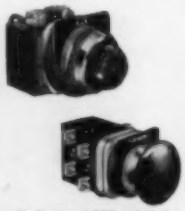
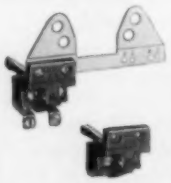


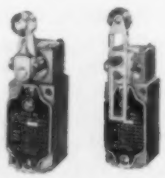
Bulletin 800T multibutton oiltight control stations



Bulletin 800T oiltight push buttons and pilot lights

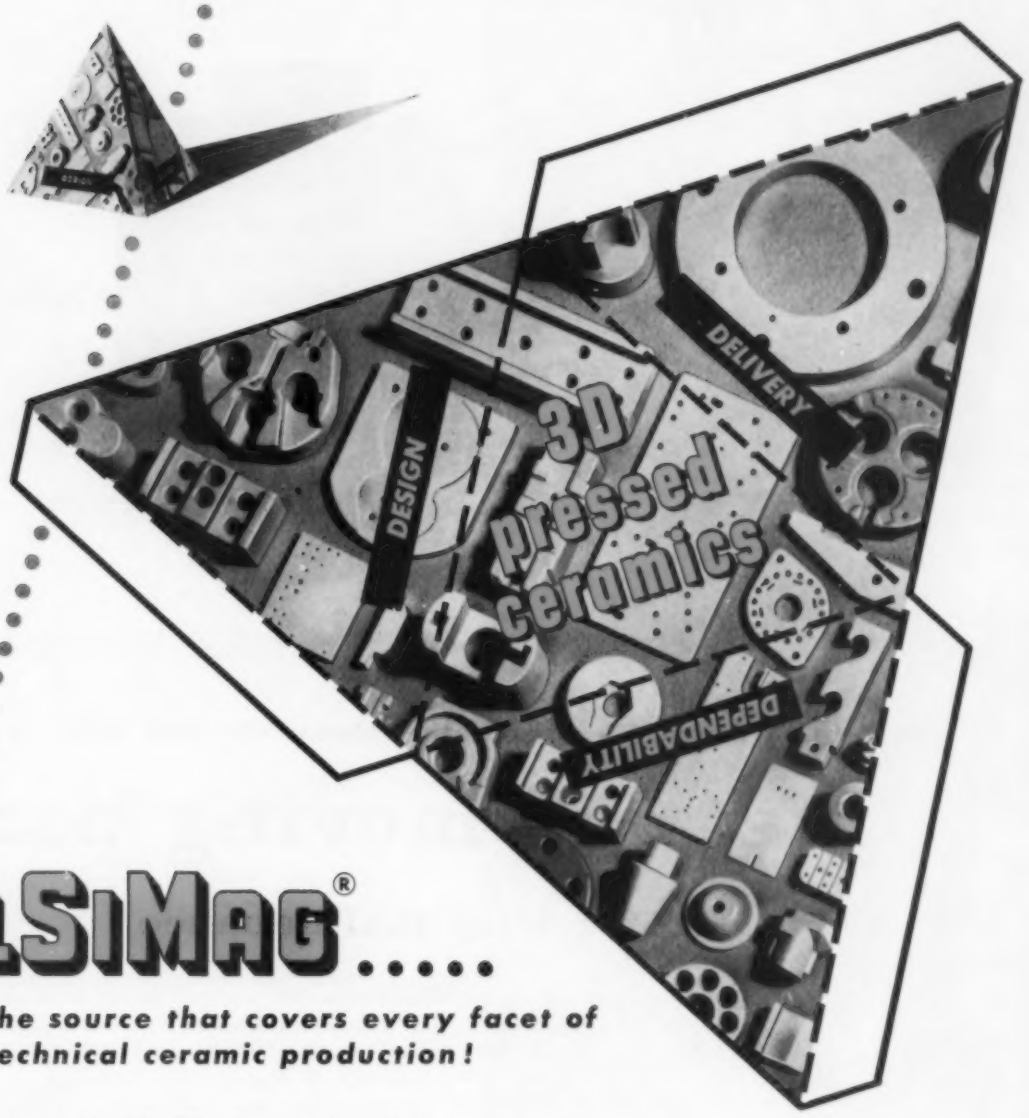


Bulletin 895 auxiliary contacts for solenoid starters



Bulletin 802T limit switches—fixed or adjustable lever

Bulletin 892 handy terminal blocks for control panels



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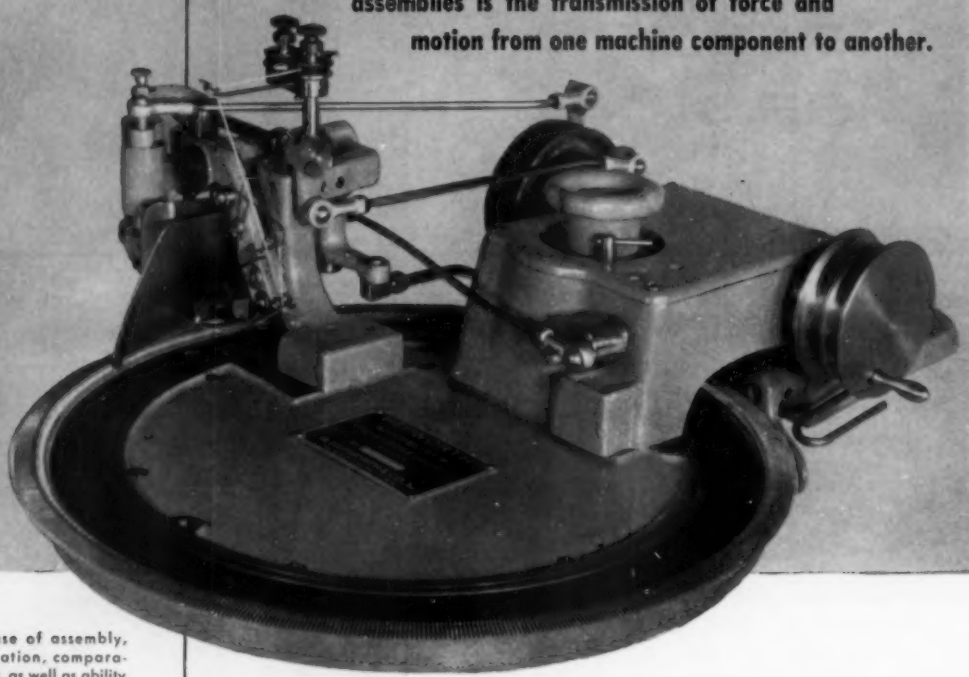

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Write for complete catalog, or for any engineering advice.

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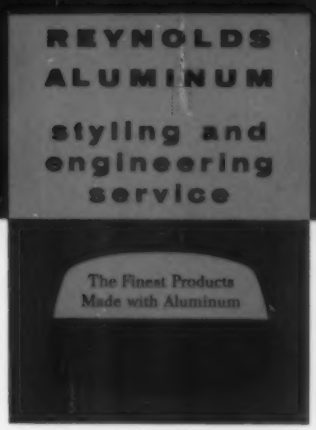

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2. **TALE OF THE POWDERED PIG** (powders and pastes and their uses)
3. **PIGS AND PROGRESS** (aluminum from mine to finished products)
4. **THE CHEMISTRY OF ALUMINUM** (chemical aspects of aluminum production from bauxite mining to metallic aluminum)

A COMPLETE INDEX

of all Reynolds Technical Literature and Films on aluminum design and fabrication is also available. Write to Reynolds Metals Company, P.O. Box 1800-HW, Louisville 1, Kentucky.

Instructors in technical schools are also invited to take advantage of these educational aids. Write for details.

The Finest Products Made with Aluminum are made with REYNOLDS ALUMINUM

DU PONT INDUSTRIAL COATED FABRICS

COATING MEDIUMS

Neoprene • Buna-N • Silicone • Polyacrylate
Chlorosulfonated Polyethylene • Tetrafluoroethylene
Butyl • Acrylic • Polyamide
Polyethylene • Polysulfide

SUBSTRATES

Fabrics	Felts or Non-Woven
Cotton . Nylon . "Dacron"*	"Teflon" Felts
"Orlon"** . Asbestos . Glass	Wool Felts
Metal . Rayon . "Teflon"***	

Also elastomer sheet stocks without fabric inserts and cements

*"Dacron" is Du Pont's registered trademark for its polyester fiber
**"Orlon" is Du Pont's registered trademark for its acrylic fiber
***"Teflon" is Du Pont's trademark for its tetrafluoroethylene fiber

DU PONT
REG. U. S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY

For the first time silicone rubber sheet stocks are available in economical continuous-roll lengths

Du Pont offers these high-grade, general-purpose sheet stocks in two hardnesses—50 and 70 durometer—and four thicknesses—1/64", 1/32", 1/16" and 1/8".

Silicone rubber sheets are designed to fill the urgent need for gasket materials in high- and low-temperature applications. Flexible and strong, these sheets are resistant to temperature extremes, oil and abrasion . . . exhibit excellent anti-stick properties.

The unique properties of these new stocks may be just what you need to make a new design a success—or to improve an old one. The continuous-roll feature means more efficiency and economy, too. Why not have a Du Pont representative call on you to discuss possible applications of silicone rubber sheets? He'll be glad to be of service. Just clip and mail coupon for further information.

E. I. du Pont de Nemours & Co. (Inc.)
Fabrics Division, PE-612, Fairfield, Conn.

I am interested in "Fairprene" Industrial Products.

( ) Have a representative call. ( ) Send further information on silicone sheet stocks.

Name_____ Title_____

Firm_____

Address_____

City_____ State_____

Quick-Opening Fasteners: Screw Type or 1/4 Turn?

Know the features of each before you specify.

M. R. TUOZZO

The selection of a quick-operating door fastener usually involves a choice between two basic designs; the quick-acting screw fastener and the ¼ turn fastener. Both are relatively inexpensive. Each has advantages that make it the logical choice for certain applications.

THE SCREW FASTENER is a rugged, square threaded screw assembly engaging in a special heavy stamped nut. The nut is clipped, riveted, or welded to the door frame. A special washer behind the thread captivates the screw in an oversize hole in the door.

Because of its exceptional "float," it is installed without precision measurements and will always line up with ease. Where a variation in material thickness may occur or a gasket must be compressed, the screw fastener is preferred, since a single grip length can be used throughout. Under most conditions it will completely disengage in two to four turns. It offers excellent resistance to vibration and forms a solid joint with no "give."

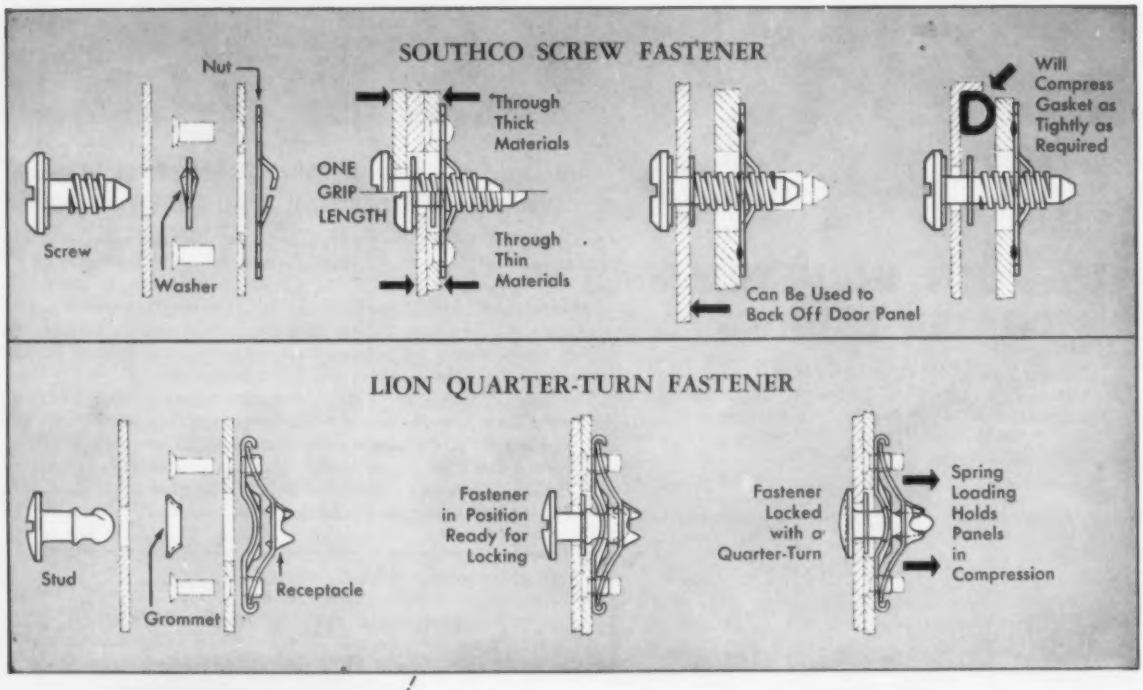
The screw fastener can be backed all the way out of the door frame without moving the door. If required, it can be installed so as to jack the door open as it is unscrewed.

THE QUARTER-TURN FASTENER is usually selected for application on aircraft (under Army-Navy-Air Force specification MIL-F-5591A) where instantaneous removal of fastened parts is required. As the name implies, it is quickly locked or unlocked by a fractional turn.

Its strength characteristics also are very high when the stud is formed from a single piece and no thin springs, wires, or cross pins exist in the assembly. The stud is retained in the door panel by a metal grommet, and engages in a full floating spring-loaded receptacle, riveted or welded to the door frame.

Where the thickness of door and frame are fairly constant through an entire production run, the quarter-turn fastener is a wise choice. Its design affords maximum speed in fastening, and excellent vibration resistance.

COMPARISON OF STANDARD QUICK-OPENING FASTENERS

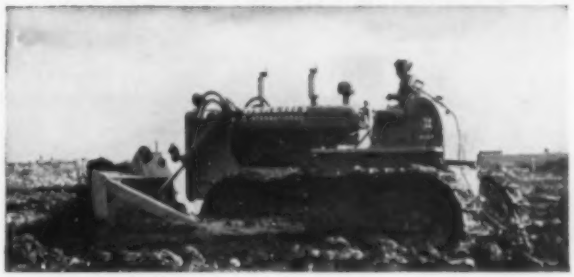


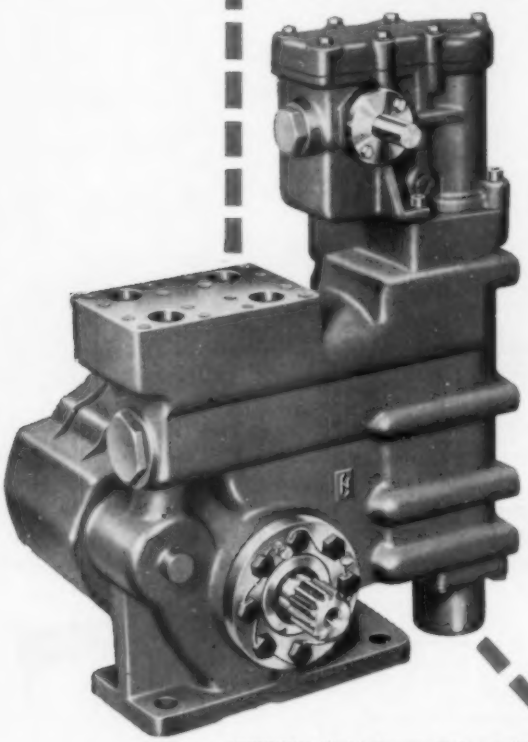
SOUTHCO FASTENERS
LION
©1956
Southco Div., South Chester Corporation
236 Industrial Highway, Lester, Pa.

CUSTOM DESIGNED
FLUID POWER SYSTEMS
Start with HYDRECO®

THE PROBLEM • • •

To provide a hydraulic system for complete control of a large bulldozer affording sensitive and positive operation of the blade. The system must be extremely rugged, of minimum weight, capable of handling upwards of 160 hp and compacted into definite space limitations.





HYDRECO Fluid Power Unit combination for International Model TD-24 Bulldozer. Rated 160 gpm at 1600 rpm — 1475 psi.

THE SOLUTION • • •

HYDRECO engineers, drawing upon years of experience in solving Mobile Equipment problems, CUSTOM DESIGNED the unit shown at the left. Here, in a single assembly incorporating Pump, Control and Auxiliary Valves, HYDRECO engineers effect an answer which precisely meets all of the requirements for the International Harvester TD-24 Dozer . . . RUGGEDNESS . . . COMPACTNESS . . . WEIGHT ECONOMY . . . PERFORMANCE AND PRICE.

The ability to CUSTOM DESIGN for the specific need can be a highly advantageous facility for YOU. CUSTOM DESIGNING serves to complement the complete line of HYDRECO Fluid Power Pumps, Motors, Valves and Cylinders which are "standard" for so many famous names in Mobile Equipment.

Write for Bulletin No. 400 describing new developments in HYDRECO FLUID POWER. Your inquiry on specific design problems is a challenge the HYDRECO engineer likes to see.

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KALAMAZOO DIVISION
THE NEW YORK AIR BRAKE COMPANY
9012 E. MICHIGAN • KALAMAZOO • MICH.
INTERNATIONAL SALES OFFICE, 90 WEST ST., NEW YORK 6, N. Y.

Write—

KALAMAZOO Division
The New York Air Brake Company
9012-12 E. Michigan
Kalamazoo, Michigan
Gentlemen:
Please furnish the following:
☐ Copy of Bulletin No. 400.
☐ Further information on HYDRECO CUSTOM DESIGNING.

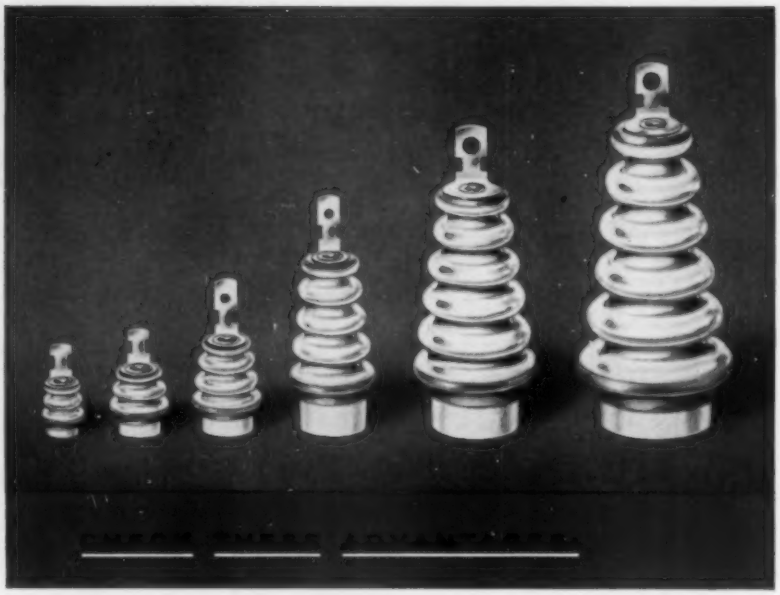
Name _____
Company _____
Address _____
City _____ Zone ____ State _____

now...

Frenchtown NICOTE Metallized Terminals!

● After years of extensive research into hermetic seal problems in the electronics and electrical fields, Frenchtown proudly presents this *improved line* of Annuluted Type NICOTE Metallized Hermetic Terminals for use in controls, relays, transformers, capacitors, motors and heater units.

Custom-engineered of HIGH ALUMINA CERAMICS and metallized with Frenchtown's exclusive NICOTE. These terminals are available in six varying sizes with a choice of terminal hardware to fit any exacting application.

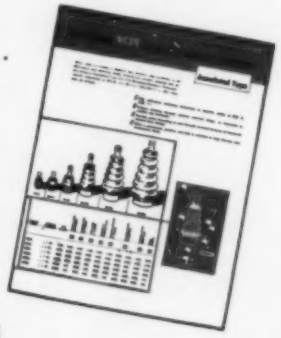


- **Will withstand *continuous* immersion in lead-tin solder at 260°C. (500°F.).**
- **Reduce tracking through superior external shape, so important in smaller size terminals.**
- **Provide easier threading of wire through terminal because of improved *tapered* bore design.**
- **Effect a permanent, positive seal that is resistant to high thermal and mechanical shock.**

NATIONAL REPRESENTATIVES
Lundey Associates
694 Main Street,
Waltham 54, Mass.
Phone: Twinbrook 3-6064

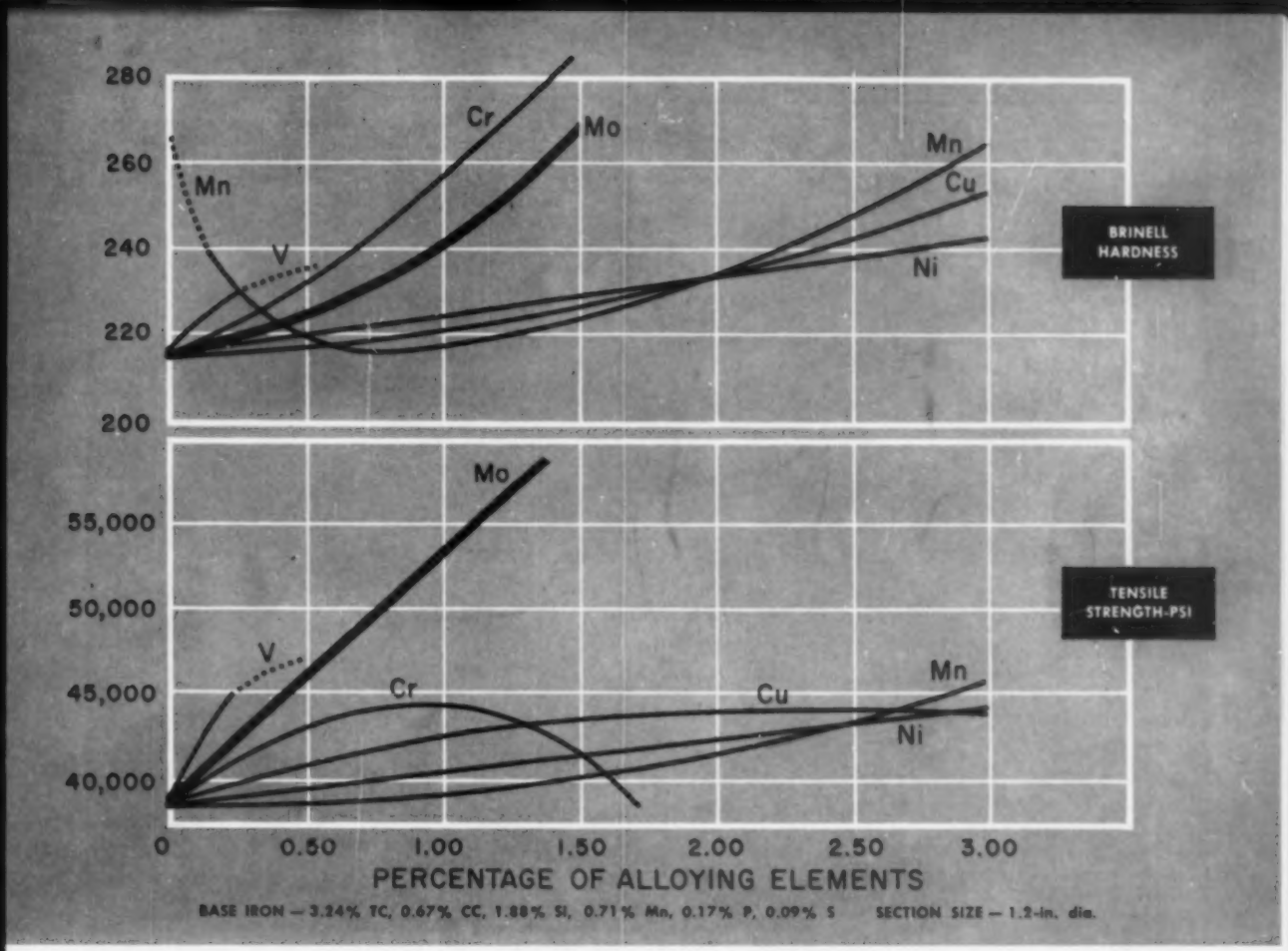
FOR COMPLETE INFORMATION . . .

. . . send for Engineering Data Sheet 1055 which provides specifications for the complete line of Frenchtown NICOTE Metallized Hermetic Terminals . . . plus engineering details on a wide selection of terminal hardware.



frenchtown PORCELAIN COMPANY

87 MUIRHEAD AVENUE | TRENTON 9, NEW JERSEY



Note how additions of moly, up to 1.5%, produce proportional improvements in strength. And, with moly, hardness increases much more slowly. It means higher strengths can be used with less danger of impaired machinability.

each ½% Moly adds 7000 psi to strength of cast iron...

A little moly adds a lot of strength – for molybdenum increases strength more than any other common alloying element, with the exception of small vanadium additions. A rule of thumb is that fifty points of moly raise tensile strength 7000 psi. And without sacrificing toughness. Actually, moly improves toughness at least as much as strength.

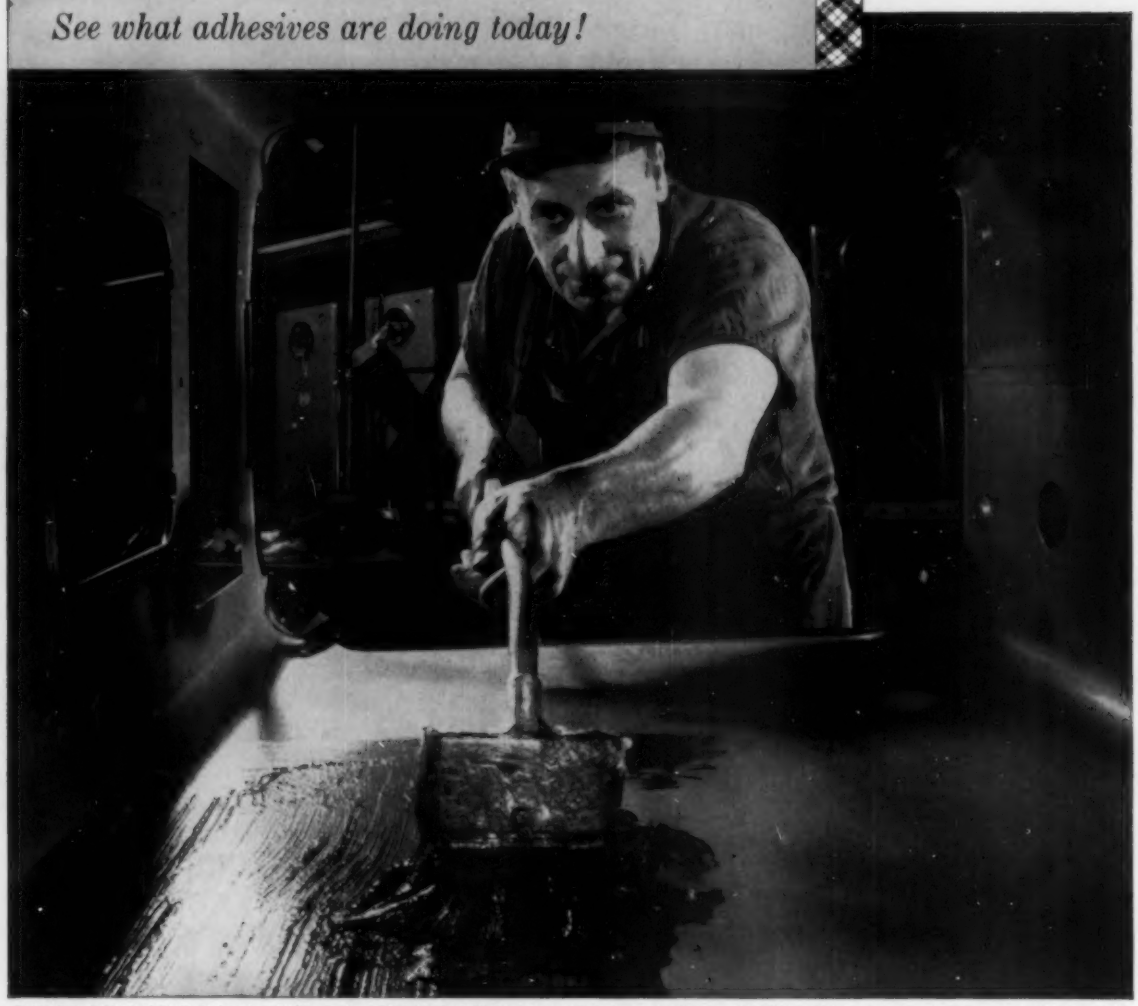
What's more, versatile moly aids in obtaining uniform response to heat treatment . . . and in producing machinable, growth-resistant castings. Moly is easy to use, too.

With most grades of cast iron, moly requires no change in the character of the charge, normal melting practice, or the base metal. And foundrymen like the fact that the small additions necessary may be made at the spout or in the ladle.

Write now for "Why Moly Iron". It's the full story of how and why moly adds strength faster than hardness, how it increases fatigue and torsional strength—in short why moly makes better cast iron. Climax Molybdenum Co., Dept. 61, 500 Fifth Avenue, New York 36, N. Y.

CLIMAX MOLYBDENUM

See what adhesives are doing today!



OUT OF THIS WORKER'S BRUSH FLOWS A MODERN FASTENER THAT SETS A TOUGHER TRAP FOR HEAT. IT'S A RUGGED ADHESIVE BY 3M.

Shooting holes in production costs

Every day this worker shoots holes in his company's manufacturing costs. The 3M adhesive in his spray gun creates a structural sandwich that's inexpensive, featherweight and strong. *Naturally this adhesive is a favorite with the comptroller.*

EC-321 fastens fibrous glass insulation inside the outer cabinet. Despite repeated heats up to 350°F., it holds the insulation tight, guards incinerator efficiency. Since this company switched to 3M Brand adhesive, the product engineer can't recall one single complaint of adhesive failure.

What's more, EC-321 eliminates the hot spots, weld marks and half the labor of former methods.

Hundreds of other 3M adhesives serve industry in a thousand varied uses.

SEE WHAT ADHESIVES CAN DO FOR YOU!

Consult 3M research. Contact your 3M Field Engineer. Or for information and free literature write on your company letterhead to: 3M, Dept. 412, 417 Piquette Avenue, Detroit 2, Michigan.

PRODUCT OF 3M RESEARCH

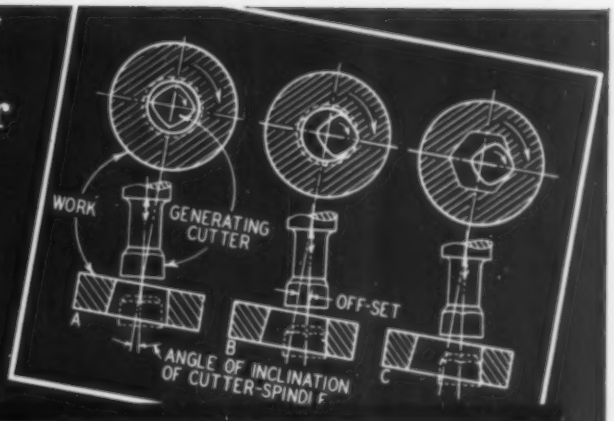
3M ADHESIVES

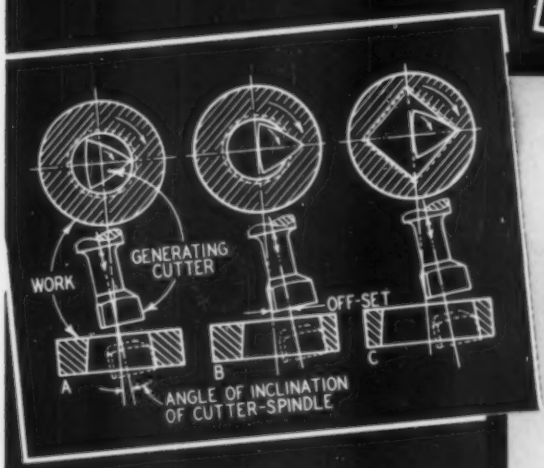
ADHESIVES AND COATINGS DIVISION, **MINNESOTA MINING AND MANUFACTURING COMPANY**

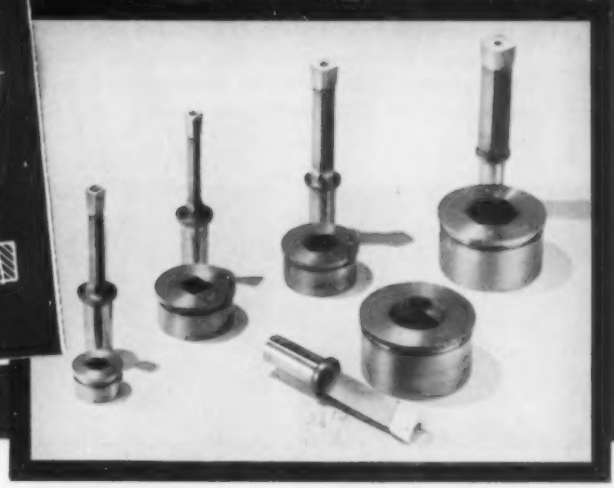
417 PIQUETTE AVE., DETROIT 2, MICH. • GENERAL SALES OFFICES: ST. PAUL 6, MINN. • EXPORT: 99 PARK AVE., N. Y. 16, N. Y. • CANADA: P. O. BOX 757, LONDON, ONT.

MAKERS OF "SCOTCH" BRAND PRESSURE-SENSITIVE ADHESIVE TAPES • "SCOTCH" BRAND SOUND-RECORDING TAPE • "SCOTCHLITE" BRAND REFLECTIVE SHEETINGS • "3M" ABRASIVE PAPER AND CLOTH • "3M" ADHESIVES AND COATINGS • "3M" ROOFING GRANULES • "3M" CHEMICALS

What every designer should know about THE ART OF GENERATING







Generating offers designers many advantages in producing an almost unlimited variety of contours. Produced by the relative motions of points, lines, or surfaces, all generated profiles are combinations of two basic surfaces: curved and straight.

Generating with a reciprocating cutter on the Fellows Gear Shaper is a low-cost method of producing a wide range of symmetrical or irregular contours, either internal or external. Gear Shaper versatility provides a choice of generating techniques—employing a cutter form conjugate to work shape, introducing a variable movement between cutter and work, or a combination of both methods.

Shown above are some trim dies and the cutters used to generate them: three-sided cutters generate the square holes and four-sided cutters the hexagonal holes. Cutter sides are curved surfaces conjugate to the straight surfaces on the dies. The drawing shows the steps in generating. A special bed tilting mechanism in the Gear Shapers provides a simple adjustment for the required taper angle on the dies.

Many other examples of interest to designers are shown in the booklet, "The Art of Generating with a Reciprocating Tool." Just write any Fellows Office.

THE FELLOWS GEAR SHAPER COMPANY
78 River Street, Springfield, Vermont
Branch Offices: 1048 No. Woodward Ave., Royal Oak, Mich.
5835 West North Avenue, Chicago 39
6214 West Manchester Avenue, Los Angeles 45
150 W. Pleasant Ave., Maywood, N. J.

THE PRECISION LINE *Fellows* *Gear Production Equipment*

It's easy to handle the new Westinghouse 48-frame motor

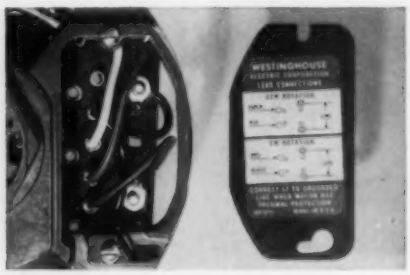
These five big mechanical advantages prove it!

Up to 35 pounds of pull will not disconnect the line cord on this new Westinghouse 48-frame motor. A built-in strain relief, one of this motor's many mechanical features, was designed with you in mind.

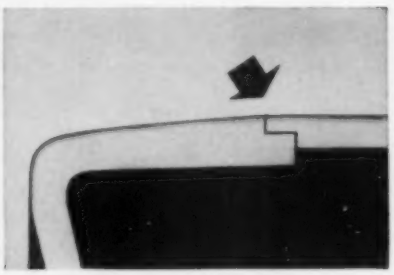
The mechanical advantages you get with the new Westinghouse 48-frame simplify your product design problems. They help speed up your assembly—make it easier and less costly. And they assure you of the permanent dependability you need and require to help make *your* product better—more salable.

For more information on the mechanical and other advantages of the new, lighter, more compact Westinghouse 48-frame motor, contact your nearby Westinghouse sales engineer. Or, write for descriptive bulletin DB-2801 to Westinghouse Electric Corporation, P. O. Box 566, Lima, Ohio. J-03030-X

POSITIVE CONNECTIONS are assured with the Westinghouse built-in strain relief for line cords. Easy-to-get-at knockout permits quick threading of conduit into spacious terminal box.



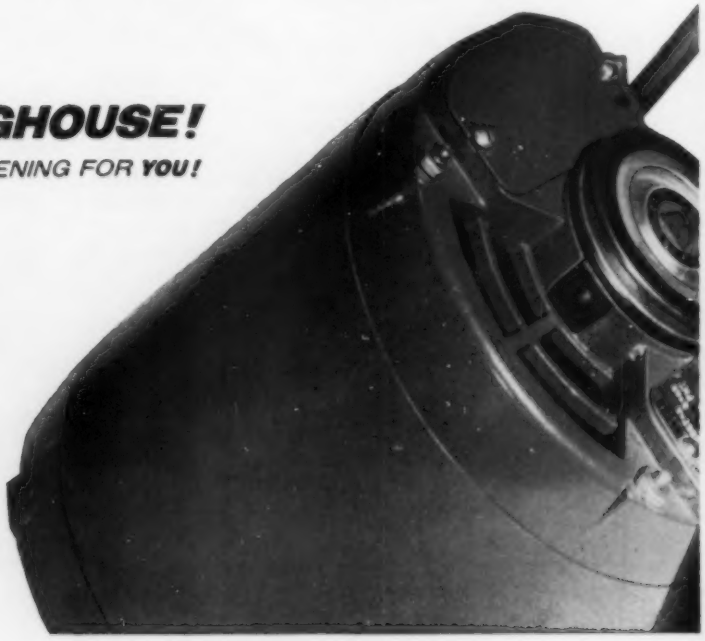
SIMPLE CHANGE of voltage and rotation is possible with easily accessible plugs on a modern terminal board. Motor's versatility materially reduces stocking requirements.

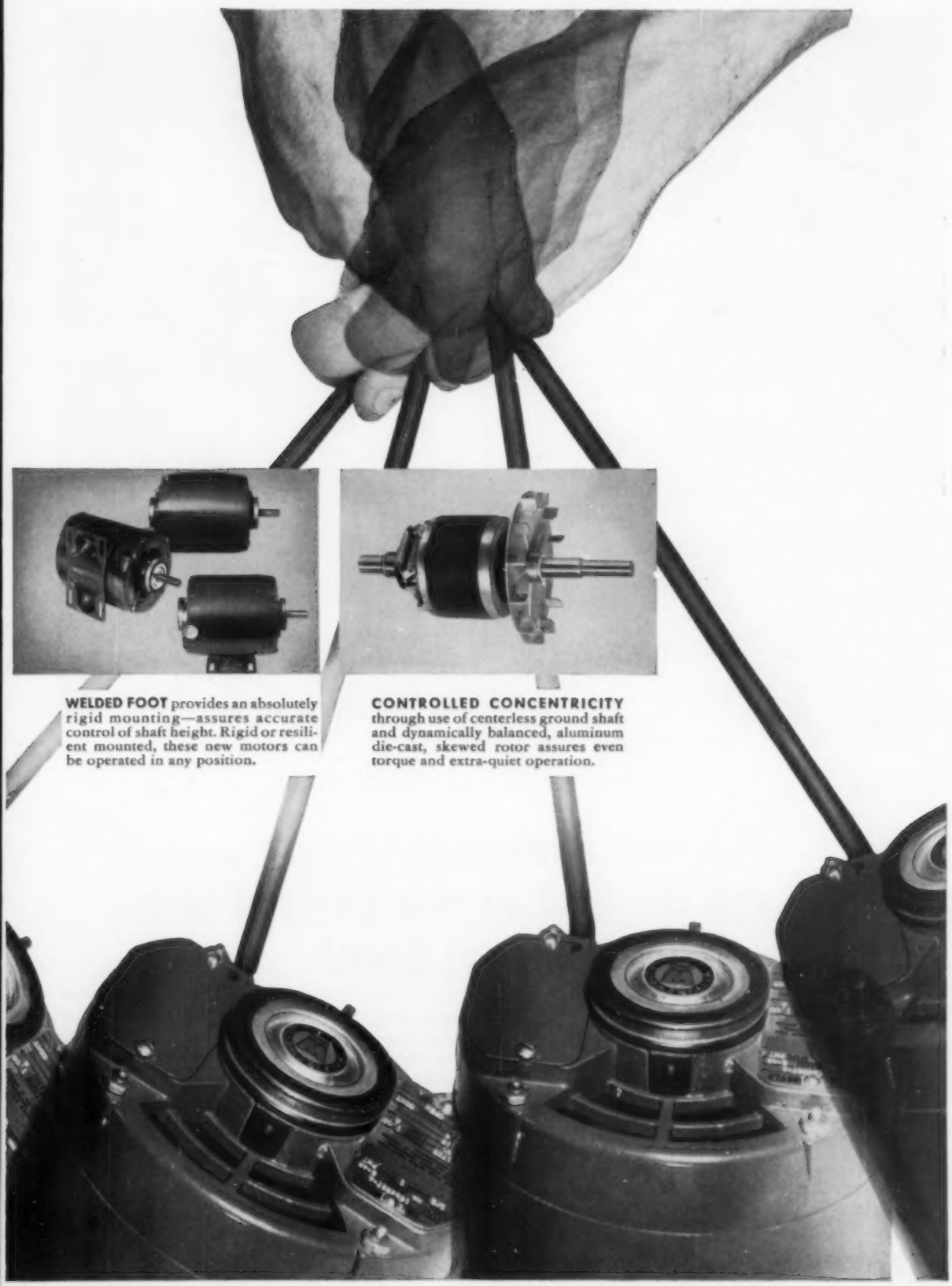


HEAVY FRAME with machined fit for end brackets assures positive alignment. Absence of "Swiss-cheese" vents in solid frame protects windings against liquids or dirt.

WATCH WESTINGHOUSE!

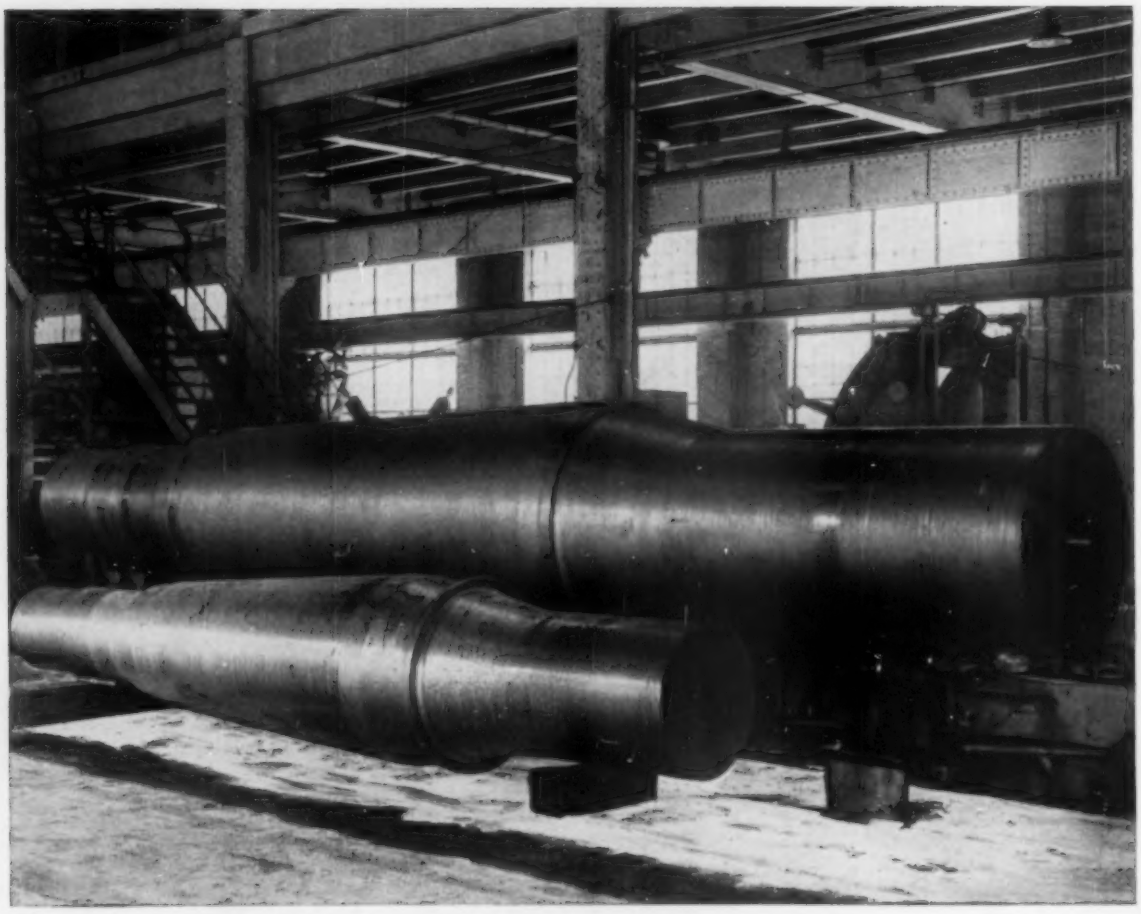
*WHERE **BIG** THINGS ARE HAPPENING FOR **YOU**!*





WELDED FOOT provides an absolutely rigid mounting—assures accurate control of shaft height. Rigid or resilient mounted, these new motors can be operated in any position.

CONTROLLED CONCENTRICITY through use of centerless ground shaft and dynamically balanced, aluminum die-cast, skewed rotor assures even torque and extra-quiet operation.



*Forged from 3½% Nickel Steel – These gyratory crusher shafts weigh 102,000 and 34,000 lbs. and are 25 and 17 feet long respectively. They were produced by Bethlehem Steel Company, Steelton, Pa.

*In large forgings like this...**

You get desired properties reliably with Nickel Steel

Usually husky parts like this cannot be quenched without special facilities.

How then do you get the superior mechanical properties often required in heavy-sectioned parts?

By selecting a nickel alloy steel that doesn't need a liquid quench to develop strength and toughness.

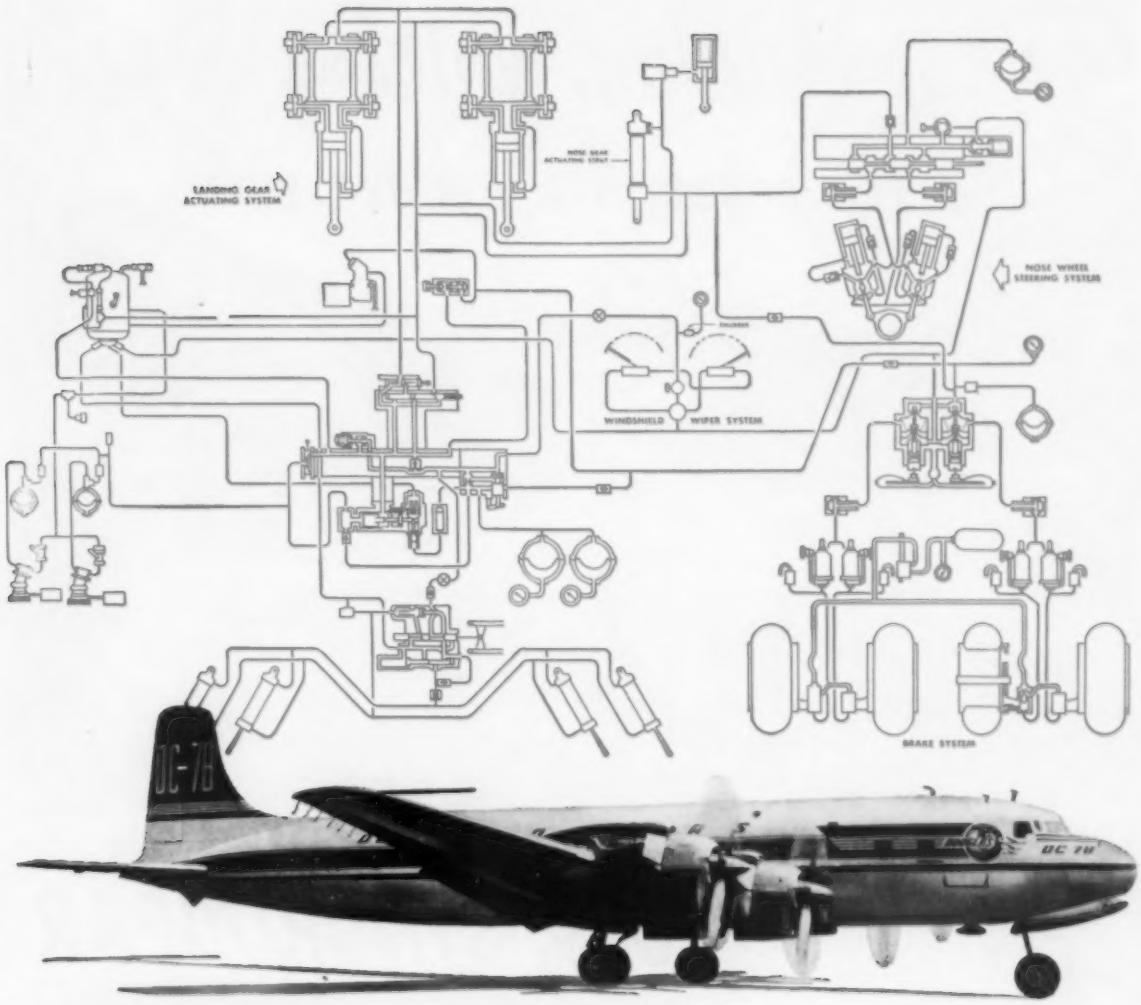
Why Nickel?

The tests of time and laws of metallurgy have proved nickel to be most valuable in developing high mechanical properties in heavy forgings. Nickel, often acting with other alloying elements, increases the hardening response of steel parts too large to liquid quench. The resulting microstructure formed gives added strength and improved toughness.

Do you have a problem?

Nickel alloy steels are used for dependable trouble-free performance in the most demanding applications. Send us the details of your problem. We may be able to help you – write today.

INCO TRADE MARK **THE INTERNATIONAL NICKEL COMPANY, INC.** 67 Wall Street New York 5, N.Y.



Enjay Butyl rubber— vital artery in newest airliners

Douglas chooses Enjay Butyl for rubber components of the hydraulic systems in many of its famous DC-7 airliners. These components, which help assure the dependable operation of everything from wing flaps to landing gear, are proving over millions of air miles their durability and resistance to wear.

Versatile Enjay Butyl rubber may well have a place in *your* operation. It will pay you to investigate the many technical advantages it has over other types of rubber. Its price and ready availability are advantages, too. For full information, and for technical assistance in the uses of Enjay Butyl, contact the Enjay Company today.

ENJAY BUTYL

ENJAY *Pioneer in Petrochemicals*

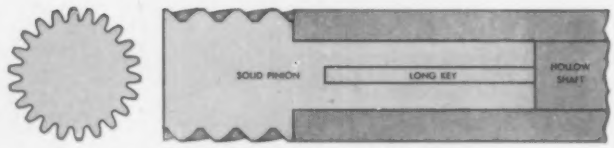
ENJAY COMPANY, INC., 15 West 51st Street, New York 19, N. Y.
Other offices: Akron • Boston • Chicago • Los Angeles • Tulsa

Enjay Butyl is the super-durable rubber with *outstanding* resistance to aging • abrasion • tear • chipping • cracking • ozone and corona • chemicals • gases • heat • cold • sunlight • moisture.

In your opinion, which pinion?

. . . for longest life in a gearmotor

ORDINARY SHELL TYPE PINION



U. S. SOLID TYPE PINION

In an internally geared motor the pinion on the motor shaft is the vital link between motor and gearing. It's the fastest, but smallest gear, so it must be extra strong, free from vibration and forever tight. Now compare the U. S. Syncrogear motor pinion with the ordinary type. Note the extra large section area of the U. S. design. It has a long solid shank that anchors into the motor's hollow shaft, whereas the ordinary shell type has a small section area, short keyed.

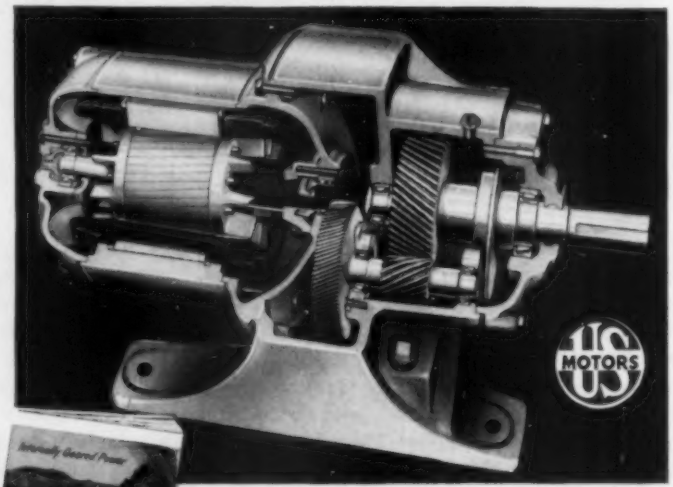
Obviously the U. S. design is most substantial, longer lasting, more resistant to deflection and can carry high speed loads far more safely than common designs. All the gears are deep-hardened and shaved to exact tolerances in the U. S. plants.

Added life lengthening features

The rugged pyramidal case supports the motor and gear train and all castings are normalized to insure permanent alignment and to prevent distortion. The motor windings are asbestos-protected to avoid carbonization and guard against burnouts. All moving parts are completely enclosed for weather and dust protection and confined within the least cubical dimensions on a single mounting. ¼ to 30 h.p.; 10 to 10,000 r.p.m.

THE ONLY MOTOR WITH A BUILT-IN PINION

U. S. SYNCROGEAR



REQUEST FOR SYNCROGEAR BOOKLET

U. S. Electrical Motors Inc. PEN-12
Box 2058, Los Angeles 54, Calif. or Milford. Conn.

NAME_____

COMPANY_____

ADDRESS_____

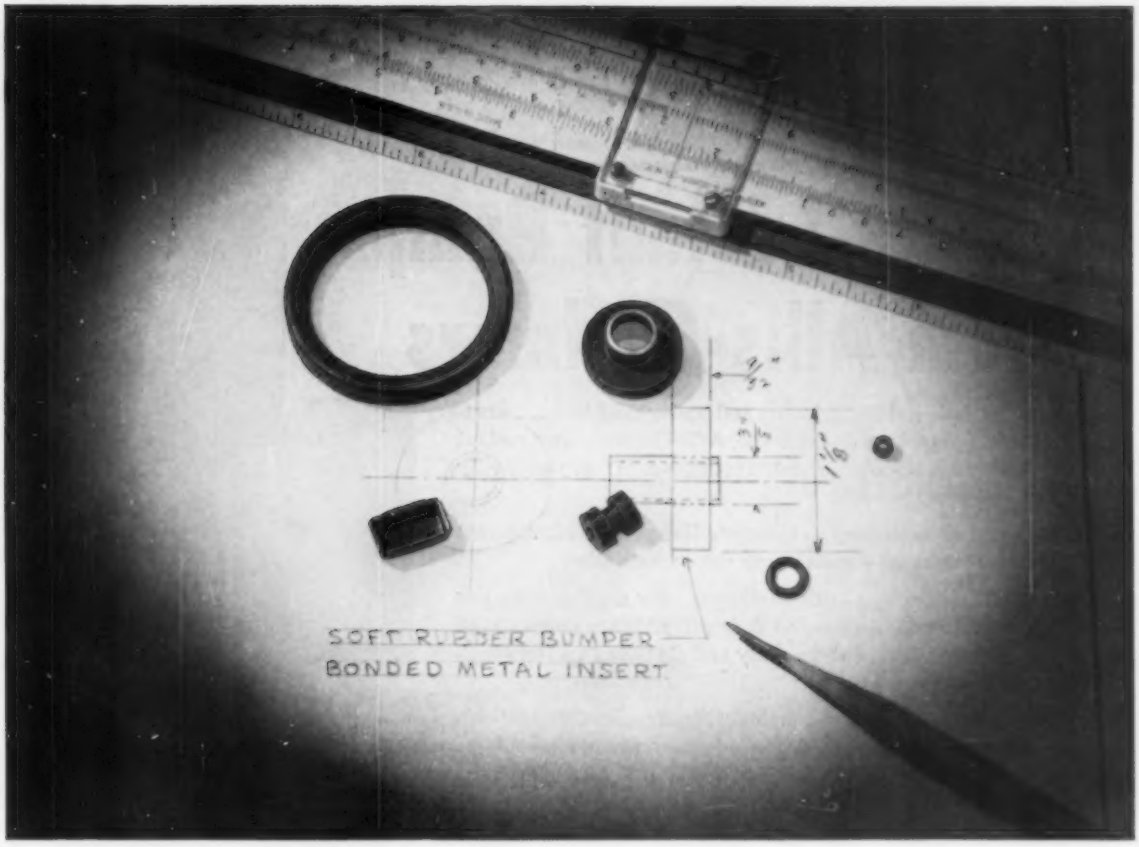
CITY_____ ZONE____ STATE_____

***FREE* 16-PAGE DESCRIPTIVE BOOKLET GIVES ALL THE FACTS**

Interesting multi-colored Booklet presents engineering facts you should know about geared motors, and illustrates the various U. S. Syncrogear types. Mail the Coupon for a copy. No obligation.

U. S. ELECTRICAL MOTORS Inc.

Los Angeles 54, Calif. **Milford, Conn.**



Super soft rubber answers many problems!

SEALS! CUSHIONS! ABSORBS SOUND!

Here's an exciting new material formulated and developed by ROTH Rubber . . . a non-porous rubber with a softness from 5 Durometer up. Applications range all the way from a tiny, sound absorbing mounting ring used in a hearing aid to bonded conveyer belts where superior gripping and cushioning qualities are required. It may be the solution to *your* problem. Check the specifications, send the coupon for a free sample . . . ROTH will be happy to work with you.

PHYSICAL PROPERTIES—ROTH RUBBER COMPOUND D992

PROPERTY	UNAGED	AGED 70 HOURS						
		212F Air	212F #1 Oil	212F #3 Oil	200F Water	85F Isooctane	85F Type III Fuel	85F Naphtha
Hardness	7	27	30	1	8	9	5	9
Tensile Strength	500 psi	750	600	250	200	450	400	580
Elongation	800%	550	550	750	550	750	750	800
Compression Set	50%							
Volume Change	*	*	−36%	+90%	+25%	−17%	+20%	−2%
Cold Bend	−60F OK −65F Brittle							

Dielectric Strength measured on 1/8-inch thick slab: At 10,000 volts the rubber passes 2 micro-amperes of current; at 15,000 volts the insulation breaks down. High Temperature Use—estimated limit 200F.

ROTH MOLDS AND COMPOUNDS RUBBER TO MEET ALL SPECIFICATIONS. TELL US YOUR PROBLEM. NO OBLIGATION!

ROTH
RUBBER COMPANY
1880 S. 54th Avenue, Chicago 50

Send for free sample OF THE RUBBER THAT FEELS LIKE SKIN!

Name_____ Title_____

Company_____

Address_____

City_____ State_____

MORE choice of Coolant Pumps from Allis-Chalmers

Broaches, lathes, drills, grinding and boring machines . . . whatever machine tool you build or use, Allis-Chalmers has a coolant pump that's *just right* for your application. When you specify Allis-Chalmers, you get:

1. Choice of mounting — Complete line permits *six* different mounting methods — makes your design job easier.

2. Choice of sealing — Depending on your requirements, you can specify mechanical seals (if clear liquids are pumped), or sealless construction (where gritty and abrasive particles are in liquid).

3. Choice of impeller — Single-suction impellers are available in either enclosed or open design—double-suction, open design.

Pump Experts from Allis-Chalmers can help you with your application. Contact your nearby A-C sales office, or write Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin.

MOUNTED ON DRILLING MACHINE, this A-C pump is sidewall mounted, is sealless, and has open impeller.

AVAILABLE in fractional horsepower and integral sizes, above model is designed for mounting on vertical surface.

VERTICALLY MOUNTED on liquid reservoir, this design operates efficiently with varying liquid levels. Available in four optional discharge positions.

SUBMERGED MOUNTED, this type of pump is frequently used on machines requiring mounting in coolant tank.

SHALLOW SUMP or reservoir use is ideal for this submerged mounted model featuring a sealless design.

A-C ALLIS-CHALMERS

A-5201

Design data on adhesives

Armstrong
ADHESIVES • COATINGS • SEALERS

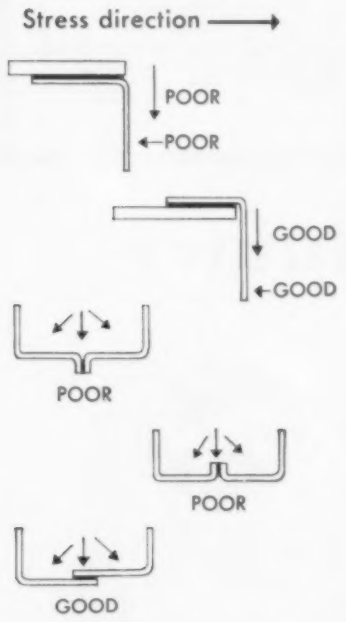
NUMBER SIX

Designing joints for flexible materials

When sheets of flexible materials are to be bonded to metal, the joints should be designed with the adhesive in shear wherever possible. Joints where the adhesive is in peel are generally less desirable and may fail when stress is applied.

In assembling thin gauge sheets to metal, particularly when bonded behind the metal, the sheet should be overlapped as illustrated to place the adhesive in shear. The overlap should be adequate to place minimum unit stress on the adhesive.

The drawings below illustrate plastic or rubber sheet bonded to metal in shear and peel, and flexible plastic bonded to itself.



For more information

Write for a copy of "Armstrong Adhesives, Coatings, and Sealers." Armstrong Cork Company, 8012 Irvin St., Lancaster, Penna.

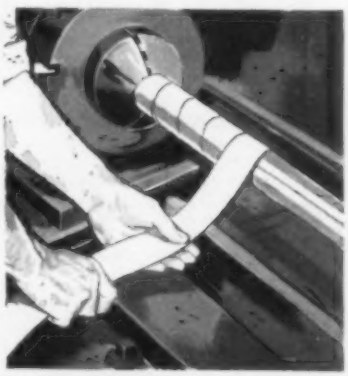
How to bond flexible materials

The first thing to be considered in bonding flexible materials is the design of the joint. Four rules, basic to all adhesive joints, must be observed:

1. Make the bonded area as large as possible.
2. Make the maximum proportion of bonded area contribute to strength.
3. Stress the adhesive in the direction of its maximum strength.
4. Minimize stress in the direction in which adhesive is weakest.

Design in Shear

Adhesives for bonding rubber vary widely from soft, tacky products to rather hard, rigid thermosetting resins. Although the rubbery adhesives generally have good peel properties, joints should be designed in shear rather than in peel where possible, as shear strength is higher.



BONDING FLEXIBLE COVERING to a steel loom roll. Adhesive is spread on the roll which is chucked in a lathe. Covering is taped on at one end, then fed on the roll, which turns at 10 rpm.

To minimize the unit stress on the adhesive, overlap should be adequate when bonding sheets of thin rubber or plastic to metal. And during assembly, tension in the sheets should be kept at a minimum, since it can result in residual constant stress on the adhesive.

Edge-Joining

Edge-joining sheets of thin flexible material may be accomplished by a simple lap joint, or they may be butted and a strap of the same material or of cloth applied over the seam. Butting sheets of heavier gauge is not practical, since butt joints in tension generally have inadequate strength.

Scarf joints have been found to be a practical solution to edge-joining of heavy sheet material. They are especially useful for strips of rubber from 3/16-inch to 3/8-inch thickness or heavier, which often require splicing or fastening to form corners, as, for example, in making gaskets. (Length of a scarf joint in rubber should be at least four times the thickness.)

Heavy Materials

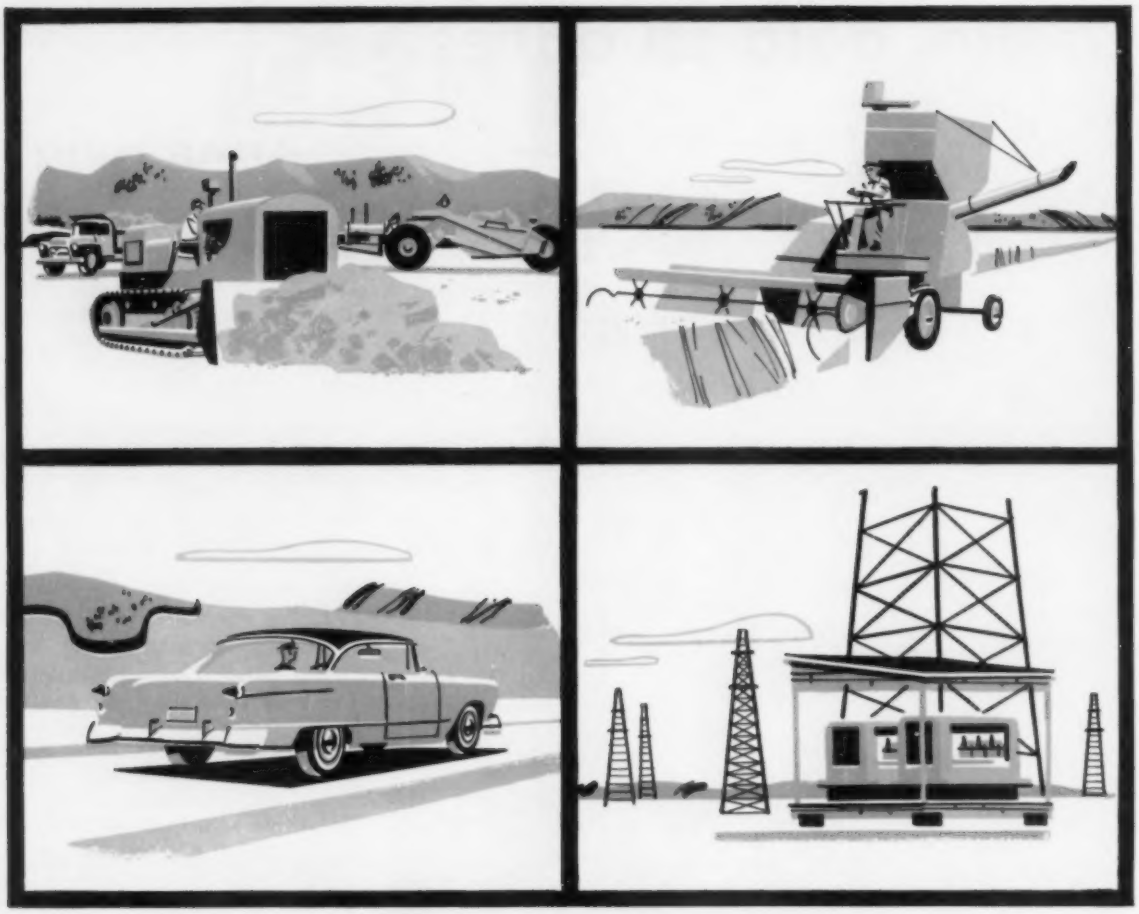
Motor mountings and roll coverings frequently involve the adhesion of heavier sections of rubber or flexible materials to metal. Under severe loading, with rubber roll coverings which allow stress to be translated through the rubber to the adhesive, failures may be minimized by improving stress distribution in the rubber next to the adhesive bond by increasing rubber hardness at the inner diameter, or by using cloth interliners.

Rubber-to-Metal

In rubber-to-metal or other flexible-rigid assemblies, stress concentrations can be minimized through the elimination of sharp corners. The metal should be thick enough to prevent peel stresses which may occur with thin-gauge metals. Sharp changes in section in the rubber or plastic can also result in stress concentrations.

Loading beyond the capacity of the bonded assembly can result not only in adhesive failures, but also in short life of the assembly due to rubber fatigue and failure. Depending on permissible cost and performance requirements, it may be possible to eliminate over-stressing in some applications by providing a bumper which comes into compression when a given deflection is reached.

Rubber-to-metal assemblies in shear or tension loading may be designed at about 50 psi and in compression at about 250 psi, although these loadings depend to a great extent on the application involved, the type of rubber, and the adhesive.



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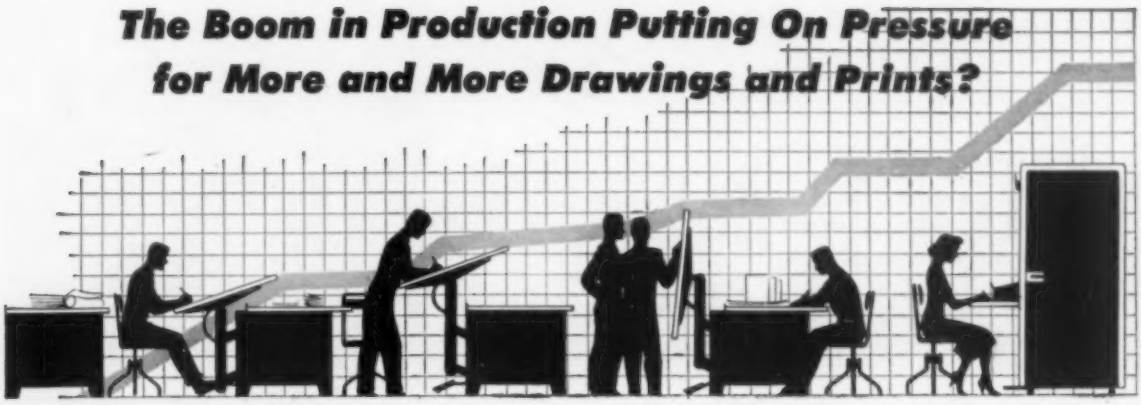
FEDERAL-MOGUL DIVISION
FEDERAL-MOGUL-BOWER BEARINGS, INC., 11043 SHOEMAKER, DETROIT 13, MICHIGAN

RESEARCH • DESIGN • METALLURGY • PRECISION MANUFACTURING

The Boom in Production Putting On Pressure for More and More Drawings and Prints?



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Two Great New Models for the Large Or Small Engineering Department!

If your company, like most others, is gearing up for greater-than-ever production, it will mean more pressure on your drafting room for engineering drawings and prints. You couldn't pick a better time to get a new modern reproduction machine. And you couldn't make a wiser choice than efficient, trouble-free Copyflex.

In just the last year, Bruning has introduced five new advanced machine models, two of which are shown here. These machines cover the reproduction needs of engineering departments, from the smallest to the largest. They offer you the famous problem-free installation and operation of Copyflex . . . no exhaust venting, no plumbing or auxiliary equipment, no installation other than an electrical connection. They bring you faster reproduction and a host of operator conveniences that will help you boost drafting room output, keep costs at a minimum.

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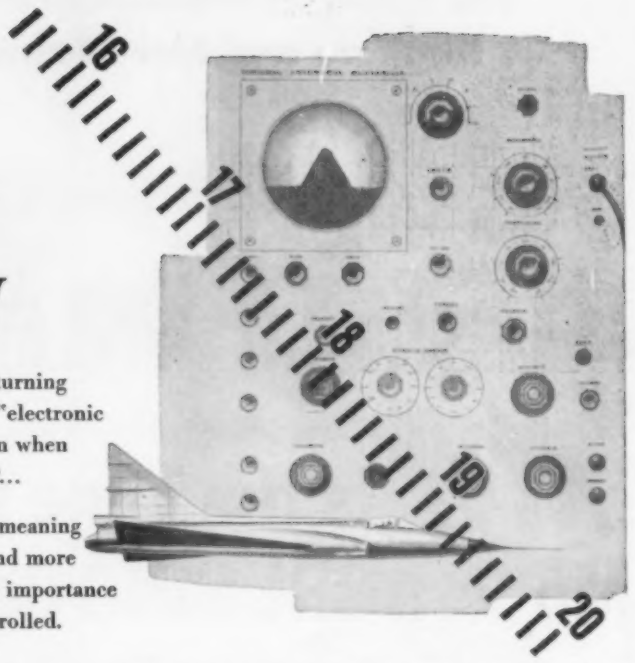
(Advertisement)

How to get reliability



Got the automation jitters?...worried about turning complex manufacturing operations over to an "electronic brain"?...worried about what can happen when one component in the control system fails?...

Reliability takes on a new and different meaning as American industry becomes more and more automated. Here are a few thoughts on the importance of reliability and how it can be controlled.

All of us are going to have to pay more attention to "reliability."

We'll have to pay more attention to individual "devices" within a system.

We'll have to guard ourselves carefully when we design the entire system.

The industrial pendulum is swinging more and more toward automatic controls, servo-mechanisms, computers, and automatic "watchers." As it does, the reliability factor becomes more and more important. Let's see why. For example, you probably have three radios at home. If one fails because a soldered joint comes apart, your home life is probably not disrupted to any alarming degree. But... consider the automatically controlled steel mill. One soldered joint failing, unless all controls are installed in duplicate (which is expensive) could tie up the entire production process for valuable minutes, if the maintenance crew has second sight. For hours, if automatic trouble-indicating and locating systems are not installed (and these are expensive, too). Last, but not least, lend a thought to the dependence of guided missiles and man-made satellites upon the reliability of electronic circuits and components. So... let's start to examine "reliability." Let's begin by looking at this definition which is currently popular in the technical field:

The reliability of a particular component or system of components is the probability that it will do what it is supposed to do under operating conditions for a specified operating time.

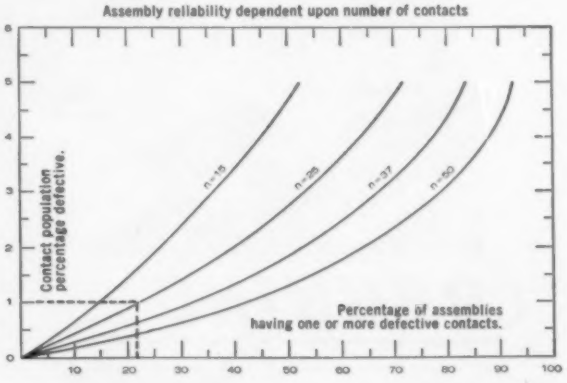
Now... this is a relatively well-accepted definition, and it offers the key to the problem of coping with failure control. Take the word "probability" in this definition. Let's discuss its implication.

Many of today's systems, simple or complex, are a chain of components. So picture a system as a chain with its successive links. In the field of statistics the over-all reliability of the chain is the mathematical product of the reliabilities of the individual links...

Overall Reliability, $R_o = r_1 \times r_2 \times r_3 \ldots r_n$

Now, let's consider a system made up of 100 different components, each of which has a reliability of 99%. In applying the formula, multiplication of .99 by itself 100 times gives an over-all reliability for the system of only 36.5%. Two out of three systems you have put together will probably fail!

Cannon becomes involved with this problem because our main business is making electric connectors. So, let's look at the following chart that covers contact reliabilities and reliability of the assembly in which they are mounted.



This chart illustrates the reliability of four connectors having 15, 25, 37 and 50 contacts respectively. As an example, assume that the contacts have a contact population of 1% defective (1 in 100 defective... this percentage is considered a fairly high standard in most fields). On the 15-contact assembly, we find from our chart that 14% of the connector assemblies would have one or more defective contacts! With 25 contacts, 22% would have one or more defective contacts. With 50 contacts, 41½%... is your hair starting to curl? Obviously, a 99% contact reliability standard for guided missile components is absolutely unacceptable. And, in between the simplest system and that of a guided missile, are hundreds of assemblies and systems whose reliability factors must be analyzed with utmost care.

But all is not lost! There's another side to the picture. With proper care, analysis, and control, our Cannon organization has actually achieved, in special "missile quality" contacts, a known level of only 2.85×10^{-3}% defective... only 1 part in 35,000! Naturally, we don't achieve that with all our contacts... but we do try to design and manufacture the utmost in reliability required for specific applications.

We have pictured this chart to show the direction we must all take, whether we're talking about connectors, other components, or systems. It boils down to two steps...

- The number (n) of components must be kept low ... *simplicity*.
- The level of component reliability must constantly be improved ... *hard work for all of us*.

Now... if we refer to our reliability definition on the previous page we note the phrase "do what it is supposed to do." So be sure *you* define these objectives for your component assembly, or system... failure to do so carefully can cause undue failure or the expenditure of unnecessary dollars for needless, excessively-reliable parts or design.

Further on in the same definition, we note the words "operating conditions." This brings up many new points for consideration. Here we are concerned with such things as temperature, pressure, humidity, corrosive atmosphere, stray electric and magnetic fields, low and high frequency noise, shock and vibration. Do your design standards need upgrading? Are your components designed and then tested to meet the operating conditions you specify... or are they designed to meet "average" conditions? Are you using adequate "safety factors"?

In a simple component, manufacturers have always looked for, recognized, and corrected faults when they occurred. We use component quality control to achieve and maintain Cannon's world famous product quality. But in complex systems such component quality control is not enough. Actually ...

Reliability control over the system is needed. It should be all-encompassing. When you get right down to it, *reliability* is the product of procedures, equipment, and people... in the design, manufacture, testing, control of quality, transportation, and use of products or systems.

Do you have a reliability control system?

Here are a few of the steps that are needed to get a reliability control system operating:

1. Determine Your Requirements. Specify the environment, operating time, performance limits, and the percent of reliability required. Allow an adequate safety factor keeping in mind the end use of the finished product.

2. Collect Reliability Data. Set up facilities for the continuous accumulation of data on component or system failures and their causes.

3. Establish quality control and test procedures which show high degree of correlation with end-use conditions.

4. Analyze. Determine if reliability requirements are being met. Establish the most important causes of failure by analyzing the data you collect.

5. Improve. Take action to eliminate the most important defects or causes of failure. Reduce the failure rate to the required level.

6. Maintain Continuous Vigilance. You have emphasized system design... you have used statistical analysis of failures... now exert continuous and critical control to be sure your "improvements" actually improve reliability. Examine new and unforeseen failure sources. Review and modify your requirements with changing conditions.

*

We at Cannon Electric are proud of our historical emphasis on quality and reliability. Since 1915 we have adhered to a design philosophy embracing the highest quality and reliability in each and every Cannon Plug for the specific application for which it is to be used. *If we can't design to that principle, we don't make it!* In manufacture, we are proud of our know-how in depth, proud of our fine quality control systems, proud of our personnel and proud of our reliability control group.

Whenever *you* have an electric connector reliability problem... in design, engineering, production, or prototype phases... we would appreciate the opportunity of discussing it with you.

Cordially,

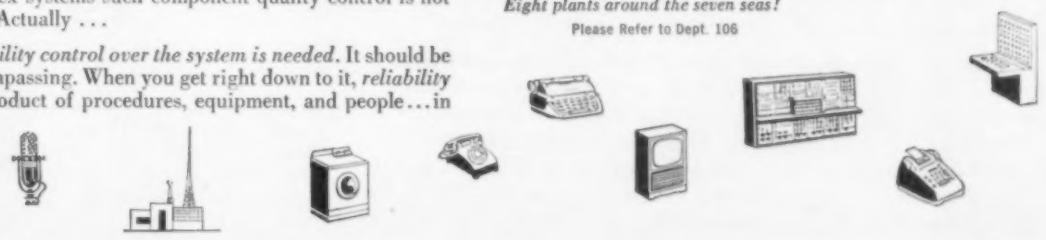
Robert J. Cannon *President*

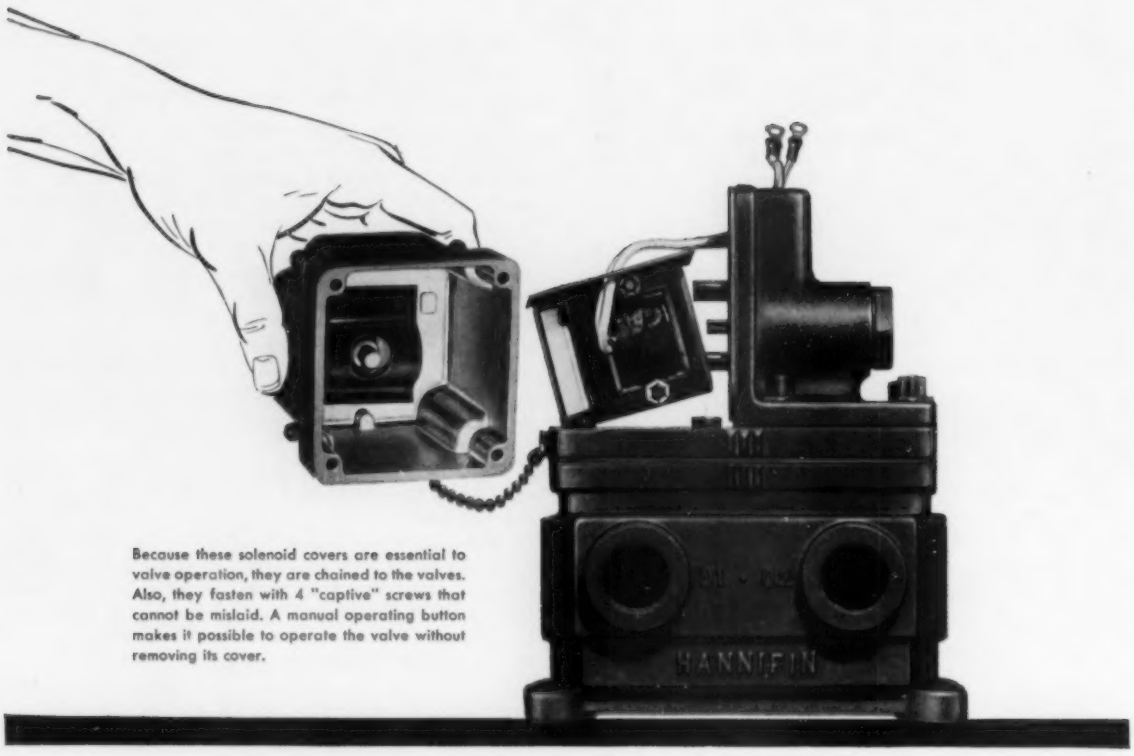
CANNON ELECTRIC COMPANY
3208 Humboldt St., Los Angeles 31, California

CANNON PLUGS

Eight plants around the seven seas!

Please Refer to Dept. 106





Because these solenoid covers are essential to valve operation, they are chained to the valves. Also, they fasten with 4 "captive" screws that cannot be mislaid. A manual operating button makes it possible to operate the valve without removing its cover.

Now! solenoid-controlled air valves that defy improper maintenance ...they won't operate with their covers off!

When a solenoid valve operates without its cover, trouble is not far off. Dirt, oil, cutting fluid, chips are sure sooner or later to jam the solenoid, and the valve will fail to shift.

That can't happen with these new Hannifin valves!

The solenoids are held in place by their covers and won't operate the valves unless the dust-tight, splashproof covers are firmly tightened.

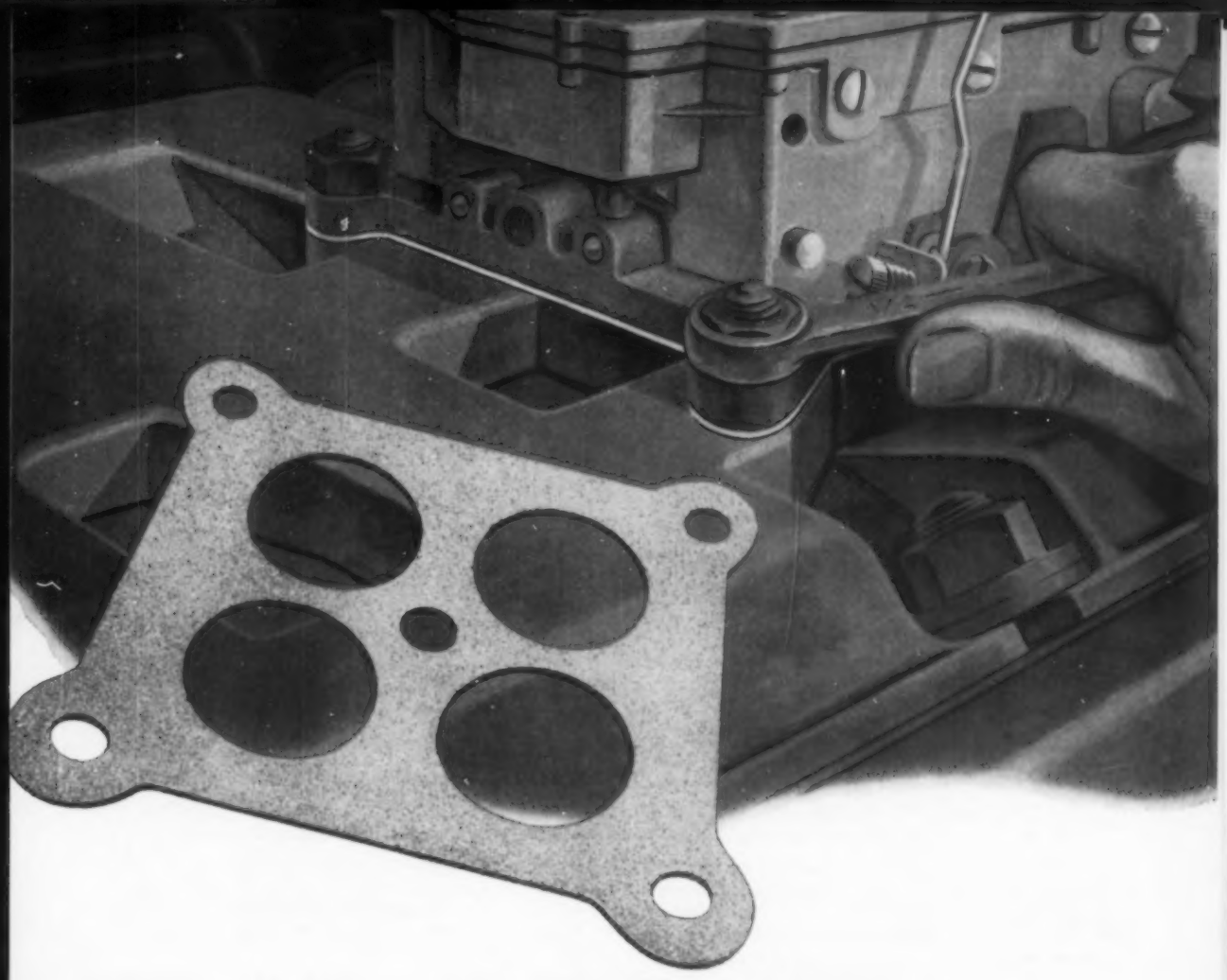
These new valves, which conform to the latest J.I.C. recommendations, are part of the complete "P-M" Pilot-Master line. New heads with these new solenoid covers are offered on 2-way, 3-way and 4-way Pilot-Master Valves (air-operated). The smaller, direct-operated 3-way and 4-way valves in the "P-M" line have been redesigned to use the same new covers. This added feature is just another reason why it pays to standardize on Hannifin air control valves.

AIR CONTROL

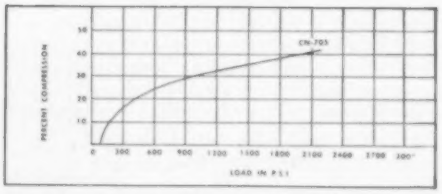
HANNIFIN

VALVES

Complete information on all Hannifin Air Control Valves is in this catalog. It belongs in your files. Write for your copy. Hannifin Corporation, 525 S. Wolf Road, Des Plaines, Illinois.



Accopac® fiber gasket seals tightly at flange pressures as low as 800 psi



LOAD-COMPRESSION CURVE SHOWS high compressibility of Armstrong CN-705 Accopac. This compressibility allows gaskets to seal under light bolt pressures normally available with light flanges.

Armstrong CN-705 Accopac—an improved fiber gasket material—becomes impervious to both liquids and gases at flange pressures as low as 800 psi. This means that CN-705 is ideal for use in lightweight metal assemblies, where low bolting pressures are necessary.

The secret of Accopac's great sealability lies in its manufacture. It's made by a special beater-saturation process that locks cellulose fibers and springy cork particles in a non-extractable nitrile latex binder. This produces a material with both high compressibility and excellent "kickback."

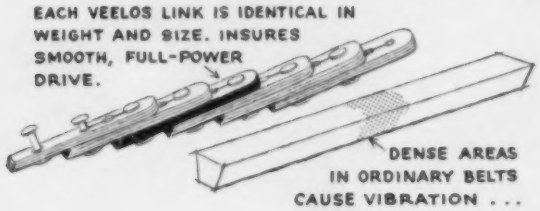
Because its binder is non-extractable, CN-705 will never shrink or dry out—in storage or on the flange. It keeps a tight seal even in alternately wet and dry applications.

For more facts about CN-705 Accopac, write Armstrong Cork Company, 7012 Irvin Street, Lancaster, Pennsylvania.

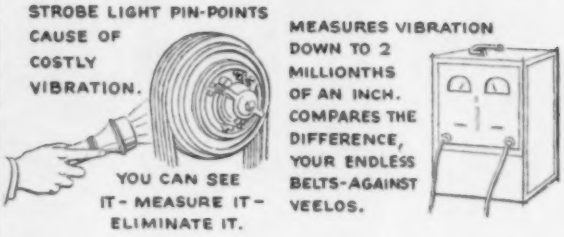
Armstrong ACCOPAC

. . . used wherever performance counts

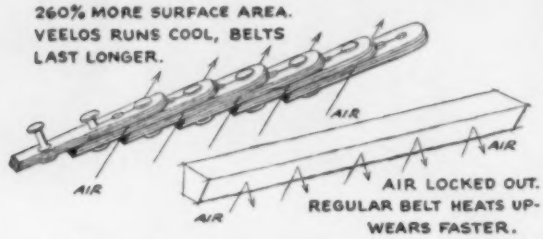
Six Reasons Why Veelos Adjustable V-Belts Are Better For Your Drives!


EACH VEELOS LINK IS IDENTICAL IN WEIGHT AND SIZE. INSURES SMOOTH, FULL-POWER DRIVE.
DENSE AREAS IN ORDINARY BELTS CAUSE VIBRATION . . . MACHINE WEAR

1. Balanced construction of Veelos Belts assures you faster, cleaner work, less rejects . . . less bearing wear. Each link and stud is identical in size and weight. Ordinary belts have varying spots of density which cause excess vibration—chatter marks, machine wear.


STROBE LIGHT PIN-POINTS CAUSE OF COSTLY VIBRATION.
YOU CAN SEE IT - MEASURE IT - ELIMINATE IT.
MEASURES VIBRATION DOWN TO 2 MILLIONTHS OF AN INCH. COMPARES THE DIFFERENCE, YOUR ENDLESS BELTS-AGAINST VEELOS.

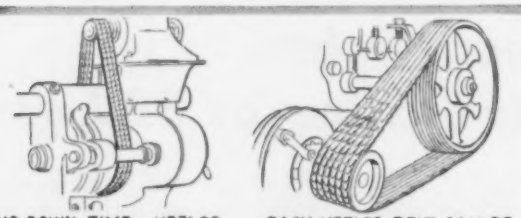
2. Electronic proof—up to 90% less vibration! With a vibration analyzer, you see, on your own machine, how Veelos belts decrease vibration up to 90% over any belt you're now using. This amazing Veelos test pin-points the belt that has the "invisible shakes."



3. Cooler running—long life! Veelos breathes! Constant circulation of air keeps Veelos running smooth. Regular V-belts have no chance to cool, heat builds up from the inside . . . causes slippage, wastes power, heats bearings, reduces belt life.

AREA CONTACT
POINT CONTACT
PERFECT VEELOS FIT. EXTRA THICKNESS AND MACHINE-CUT SIDES PREVENT BOTTOMING. MEAN CONSTANT POWER.
POWERLESS POINT CONTACT OF ORDINARY V-BELT. BULGES, SLIPS, CAUSES UNEVEN SHEAVE WEAR.

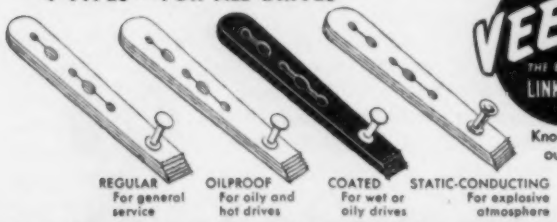
4. Greater flexibility reduces slippage! Sectional construction, beveled links allow greater flexibility, longer belt life. Each link moves around sheave independently and maintains full contact, constantly. Full area contact allows shorter centers, smaller sheaves.


NO DOWN-TIME. VEELOS FITS ANY DRIVE - WITHOUT DISMANTLING.
EACH VEELOS BELT CAN BE ADJUSTED - NO NEED FOR EXPENSIVE MATCHED SETS.

5. Simple installation "knocks out" down-time! Saves up to 50% installation time on outboard bearing drives, more when belt length isn't in stock. No resetting, tilting or moving motors. Veelos can be made any length, can be changed by adding or removing links.

6. Veelos won't stretch any more than ordinary endless V-belts when it is properly installed. *Remember—measure Veelos 1" short per foot and roll on drive as tightly as possible.* With the first few revolutions Veelos studs accept a permanent set into the sections they connect.

4 TYPES — FOR ALL DRIVES


REGULAR For general service
OILPROOF For oily and hot drives
COATED For wet or oily drives
STATIC-CONDUCTING For explosive atmosphere

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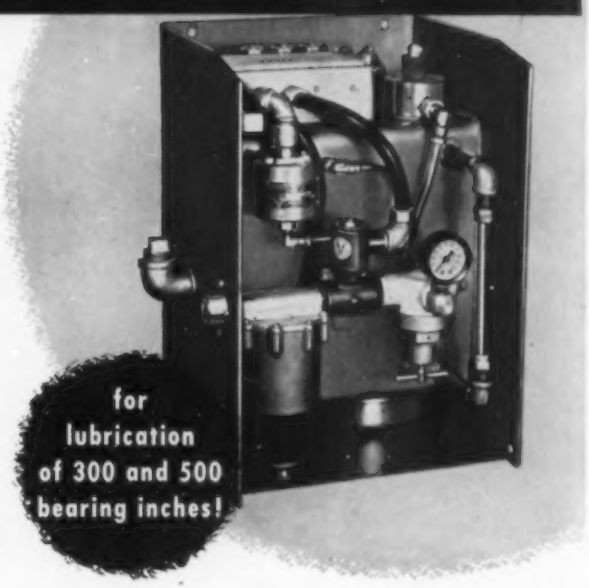
2 new ALEMITE OIL-MIST

AUTOMATIC LUBRICATION MODELS



Greater capacity . . . greater coverage . . . greater savings! Now the largest machines can have moneysaving, timesaving Alemite Oil-Mist Automatic Lubrication! These two new models offer greater capacity for lubricating up to 300 and 500 bearing inches! They are the same type of famous Alemite Oil-Mist systems already proved on countless machines in all types of industry.

Alemite Oil-Mist Lubricators atomize oil into mist and distribute it through tubing to all types of lubricated mechanisms—anti-friction and plain bearings, gears, slides, ways, chains, cams, and rollers. Amazingly simple, continuous and fully automatic . . . Alemite Oil-Mist eliminates the waste and uncertainties of the "human element" in lubrication.

Design more efficient, more economical, foolproof automatic lubrication into your machines. Mail coupon below for full details!

8 Advantages of the ALEMITE OIL-MIST System

1. Continuous Lubrication—Constantly deposits fresh, clean film of oil on all surfaces of all bearings in the system.

2. Fully Automatic Lubrication—Can start and stop with operation of machine switch.

3. Elimination of Guesswork—No bearing can be overlooked, nor overlubricated! Every bearing picks up only as much Oil-Mist as it needs. Eliminates waste.

4. Reduction of Bearing Temperatures—Acts as bearing coolant, can lower bearing temperatures as much as 20° F.

5. Reduction of Types of Oil—Reduces number of oils that must be stocked, handled, and applied.

6. Elimination of Downtime—All bearings in the system are constantly lubricated while machines continue to operate. Production goes up!

7. Extension of Bearing Life—Multiplies bearing life many times. Life of grinding machine bearings has extended from 400 to 7,000 hours!

8. Less Oil Consumption—about 1/10 the amount consumed by any other lubrication method!

Alemite Oil-Mist Lubricates ALL Types of Mechanisms

Anti-friction Bearings | Plain Bearings | Chain | Gear | Gear Cases

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A Product of STEWART-WARNER CORPORATION

Alemite Division of Stewart-Warner, Dept. T-126
1850 Diversey Parkway, Chicago 14, Illinois

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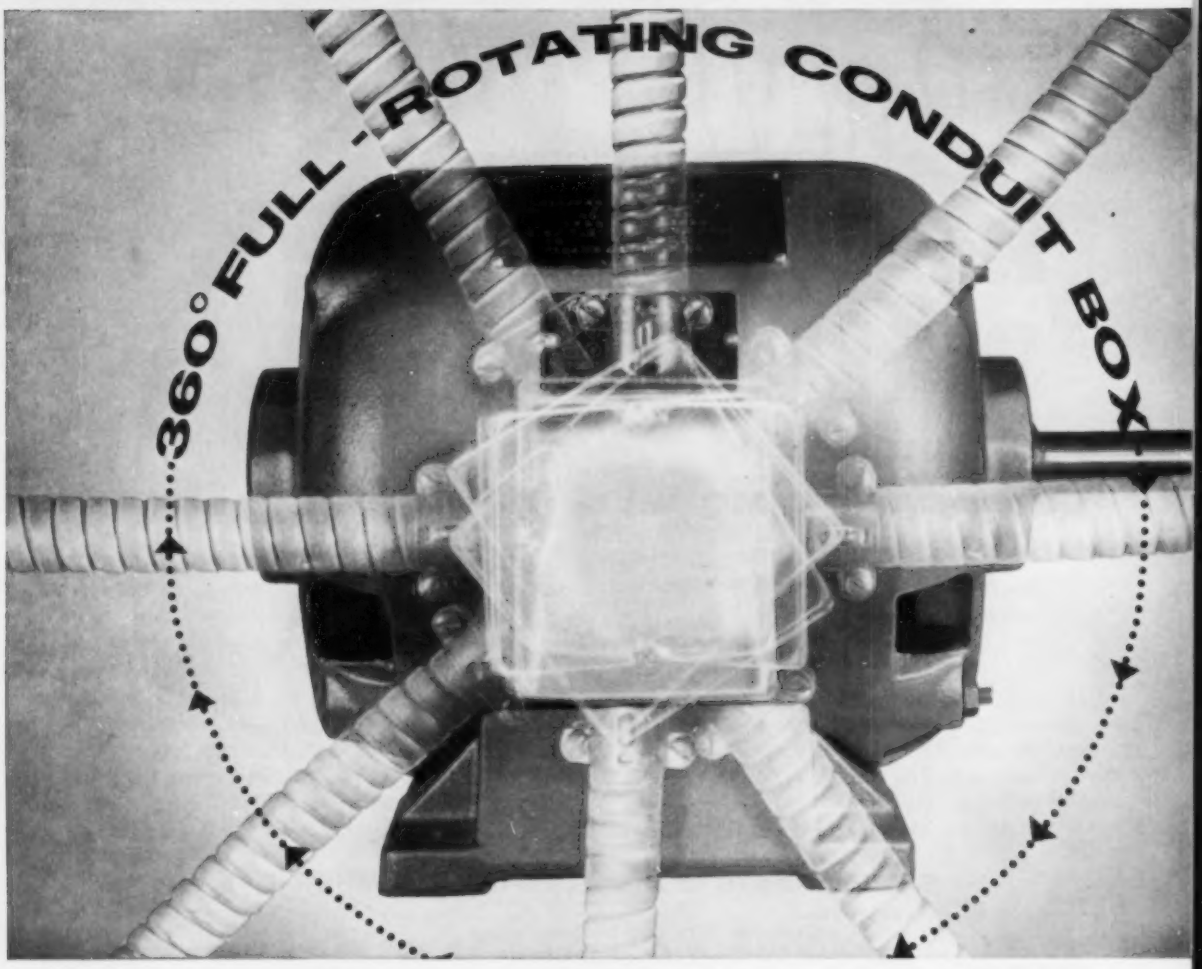
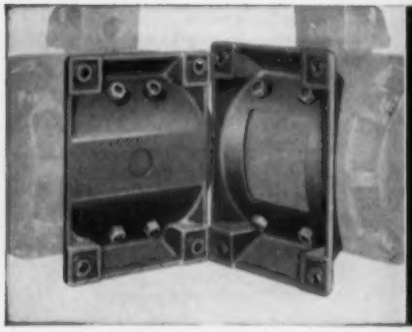
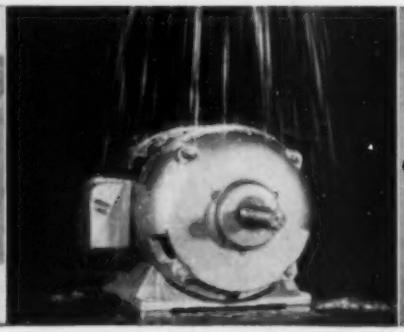


You get these quality A. O. Smith motor features...



OPTIONAL FRAME MOUNTINGS

There's no need to change product design to use new NEMA frame sizes. A. O. Smith gives you frame mountings drilled to old and new specifications.



DRIP-PROOF CONSTRUCTION

Motor can be mounted in any position . . . drip-proof thru 360° cycle . . . simply rotate end brackets. No foreign matter can enter vent holes.

PRE-LUBRICATED BEARINGS

Shielded bearings assure protection against over greasing . . . provide even load distribution under all working conditions . . . quiet operating.

A. O. Smith integral hp motors

Saves space... speeds motor installation... convenient design for easy connection of leads

JUST one example of the many exclusive features you get with A. O. Smith integral hp motors is the full-rotating conduit box. This advance design permits you to connect terminal leads from any angle without re-positioning the motor once it's installed.

The conduit box may be rotated through a full 360° by simply removing the cover and loosening three screws. And a special gasket is used to seal-out the moisture... no chance for corrosion, a major cause of power failure.

It's good business to specify A. O. Smith integrals, because you get motors that are application-engineered to match the performance and quality of your product. You can say goodbye to the problem of adapting your product to the design limitations of conventional motors.

And remember — for your design or speed requirements, there's an A. O. Smith integral hp motor available to power your products. Integrals are built in single-phase (1-7½ hp) and polyphase (1-150 hp)... in various speeds and frequencies... choice of frame mountings for either old or new NEMA dimensions... C and D flanges as required.

Produced by one of America's great industrial concerns, these motors are backed by a national network of 270 strategically located factory service stations. There's one near you — ready to provide 24-hour service on all parts and service orders.

For more information on A. O. Smith integral hp motors, write for new Bulletin No. EM156.

Through research ... *a better way*

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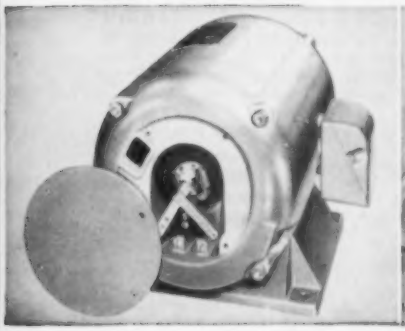
CORPORATION

ELECTRIC MOTOR DIVISION

TIPP CITY, OHIO

International Division: Milwaukee 1, Wisconsin

application-engineered to match your product requirements

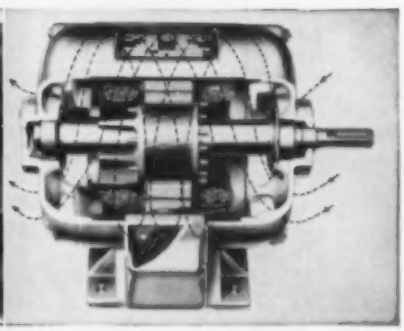


SEALED STARTING SWITCH AND ACTUATOR

Exclusive development... totally-enclosed in end frame. No need to remove motor from line for switch service.

DYNAMICALLY-BALANCED ROTOR

Assures continuous, vibrationless, trouble-free performance and maintains long bearing life. Indestructible laminations are high-quality silicon steel.



CONTROLLED THRU-VENTILATION

Cooling system designed for high-volume, low velocity air for maximum heat transfer. Temperature held to absolute minimum, assuring longer insulation life.

NATCO ENGINEERS

OVERCOME DISTORTION

DURING MACHINING

WITH

STRESSPROOF®

SEVERELY COLD-WORKED, FURNACE-TREATED STEEL BARS

The Lead Screw Tapper Spindles of this Natco Three-way Holetapper required machining operations hard to combine without serious distortion.

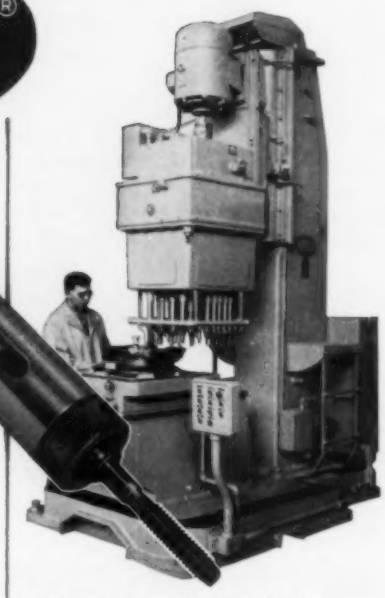
The front end of each spindle had to be machined as a taper socket for collet application. When the driving keyway and the tool knockout elongated-splined-holes were machined, distortion caused out-of-round taper holes which would not receive the collet correctly.

The rear end of each spindle had to be machined as a driving spline shaft which slides under load. Since the diameter of the spline is relatively small in proportion to the shaft length, any attempt to heat treat caused distortion hard to correct by straightening.

And at the center of each spindle, an accurate lead screw had to be machined by a thread grinding operation. It was found that the finish was much more easily obtained when STRESSPROOF was used.

STRESSPROOF eliminated both the problem of the out-of-round taper holes on the front of each spindle . . and the distortion of the driving-spline-shaft.

STRESSPROOF makes a better part at a lower cost.



National Automatic Tool Co. has for many years used STRESSPROOF in the manufacture of important operating parts for this Three-way Holetapper, as well as for other Natco high-speed machine tools.

WRITE TODAY FOR Helpful Data Bulletin No. 15 "Improve Quality —Cut Costs"

AVAILABLE FROM LEADING STEEL DISTRIBUTORS COAST-TO-COAST

La Salle STEEL CO.

1430 150th Street, Hammond, Indiana

MANUFACTURERS OF AMERICA'S MOST COMPLETE LINE OF QUALITY COLD-FINISHED STEEL BARS

Perspectives

IN DESIGN AND DEVELOPMENT

SCIENTIFIC PERSONNEL IN GOVERNMENT

It was only back in the thirties that people would point to a government scientist or engineer and say, "Is he smart enough to work for the government?" About the same time government research laboratories were getting 90 per cent of the top ten per cent of a college graduating class.

Times have changed. With the great demand for such qualified scientists, and the salaries to go along with them, the government is having a hard time getting its quota of men. The 90 per cent figure mentioned above is no longer true. And, what is most disturbing to the authorities is the loss of some of its better men—older men who would be expected to remain loyal to their jobs. Significantly, these men are not leaving for a slight salary increase. They are leaving for a whopping 50 to 100 per cent increase over their present government salary. Many of these men are reluctant to break the ties of 15-20 years or more of friendship, but insistent demands by private industry, plus the feeling that in fairness to their families they could not turn down such fabulous salary offers, the men finally accept.

WHY THE LOSS?

Why the loss of these good men? As one government laboratory director admitted, "The government is buying its own professional murder. Private research groups are offering our people much higher salaries because of the big government contracts their companies get. The increase of funds for the ballistics missile work caused this research manpower problem. Companies are building laboratories all over the place; and where do they expect to get the people to operate them?—government labs of course. The situation will get worse before it gets better. Government laboratories must exist so that there will be a group working in a specialized field in case of an emergency. Certainly industry could not do this in peacetime and expect to make a profit."

WHAT'S BEING DONE

The government scientific manpower problem is recognized in the high levels of the Department of Defense, and progress has been made to put such government personnel on a competitive basis, salarywise, with industry. The heart of the problem is the inflexible civil service system, whose classification system is the chief bugaboo. For example, up to last August a college graduate with a bachelor's degree in science or engineering could get a job in one of the government laboratories earning $4035, and starting in the GS-5 classification. One year later he would be advanced to GS-7, earning $4455. (Professional positions begin at GS (General Schedule) -5, and are progressed to GS-7 to GS-7, and to GS 11. Then, advance is by single grades.) A year later, he would reach GS-9 and about $5,000.

The new pay scale which went into effect in August requires each government laboratory to have an intensive training program for its employees in order that they may qualify for the stepped-up GS classification salary

(Continued on page 131)

Big News in Stereo Viewers

Chicago Molded uses phenolic of top dimensional stability

The new, prestige-building Realist Stereo Viewer at the left is now being offered by the David White Company of Milwaukee, Wisconsin. It features: optional power for illumination – *either from a light socket or battery;* knob-easy brightness control; a new focusing adjuster; a thumb wheel interocular adjuster that permits each viewer to set the proper distance between eyes.

The viewer is making big news in plastics, too! The eleven parts you see above are all custom molded. For top dimensional stability so vital in precision optical equipment, Chicago Molded has used an improved, compression molded phenolic that is highly impact resistant. For sales appeal and quick product identification six parts are a sprightly green polystyrene. For production economy, all six have been injection molded at one time in a six-cavity mold.

Whatever your new product needs, you'll find *it pays* to call in Chicago Molded. CMPC engineers keep abreast of developments in plastics to help you make your product more saleable, yet less costly. *That's why 60% of our business comes from firms we've served for over 15 years.*

Write today for a free subscription to *Plastics Progress,* Chicago Molded's data packed magazine on up-to-date developments in plastics.

CHICAGO MOLDED PRODUCTS CORP.

1032 North Kolmar Avenue, Chicago 51, Illinois

advance schedule. At the U. S. Naval Ordnance Laboratory, for example, the same college graduate with a bachelor's degree starts in GS-5 at $4480. In one year he is advanced to GS-9 and $6115, a salary boost of $1635. One year to 14 months later, he is advanced to GS-11 and $7035. The next increase to GS-12 and about $7800 takes a year and a half, and from GS-12 to GS-13 and $8990 about 2½ years.

It can be seen that within the first four to five years of employment, the employee's rate of advancement in government work is competitive with his counterpart in industry. Here the government curve starts to flatten out while the industry curve goes on up. The GS grades go up to a top of GS-18 which pays $16,000. The Technical Director at the Naval Ordnance Laboratory, the highest civilian position in the establishment, is worth only $15,000 under the classification system. For this he supervises close to 3,000 employees and administers $35-million worth of research.

As one goes higher in such government work there are fewer jobs available to command salaries of $15-16,000. The National Bureau of Standards lost an excellent prospect because he knew of the "ceiling" at the Division Chief level which pays $12,500. To go higher would mean becoming an Associate Director of NBS, and there are only four of these.

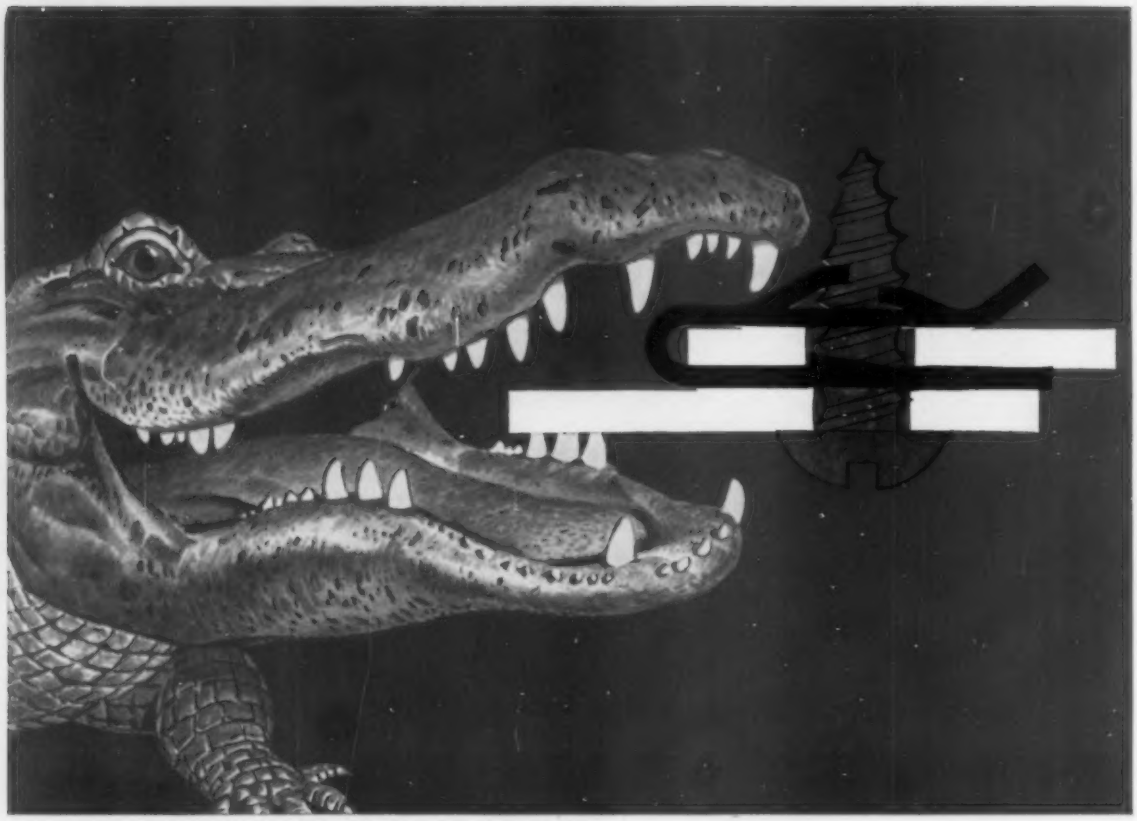
THEY LEAVE THEN RETURN

Of the people who did leave government work, many did so because they did not want the administrative work, and details. They found that they could get a higher salary in industry working at the bench. The Naval Ordnance Lab rectified this with a double line of advancement. Now a person can get up to GS-14 and $11,395 doing strictly technical work.

Of those who leave government work to go to industry, many return realizing that they made a mistake. One said that he found utter confusion in private industry. Another said that he had nothing to do; the company wanted him around in case something did come up. Another said that while he was getting the same salary in strictly technical work, he was not able to have the same voice in management that he had at NOL. Finally, many were used to the freedom in a government research laboratory which permitted them to work on any project they desired with the excellent lab facilities.

WHY MANY STAY WITH GOVERNMENT WORK

Using the overworked phrase, "Money isn't everything," actually well describes the sentiment of a number of people who are happy with their government job. The Diamond Ordnance Fuse Laboratory formerly with the National Bureau of Standards, but now under the Army's Bureau of Ordnance, is presently conducting a study which will permit them to predict the turnover they will get. One of the questionaires sought to determine the attitude of its employees to their work. Most prominent answers were: (1) People in the GS-5 classification felt strongly about devotion to country and that they were doing something to preserve the American way of life; (2) a sense of competitiveness between Diamond Ordnance Fuse Lab and any other lab; (3) at the GS-12 level the employee feels that he is part of the management team and is motivated the same as the person in GS-5. This loyalty factor was found to exist in the Navy as well.



STEEL JAWS THAT NEVER RELAX
fasten a fastener in place

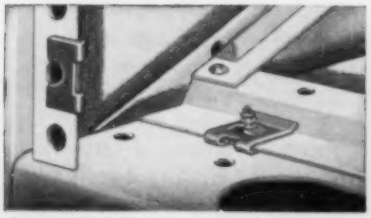
Alligator jaws have nothing on Tinnerman "U" and "J" type fasteners in gripping power. These fasteners press easily into locked-on position over panel edge or center panel locations. Yet they provide positive self-retention, ending the need for welding, staking or other secondary fastening devices. They are ideally suited for blind assembly or hard-to-reach locations.

When combined with the familiar Tinnerman SPEED NUT, this unique fastening principle provides a one-piece, self-locking, self-retaining fastener that is fast and easy to apply. The "U" or "J" feature can be combined with wire and tube retainers, latches, catches and a host of other fastening requirements to save time, material and production costs.

Find out about these and more than 8,000 other types of SPEED NUT brand fasteners now serving industry all around the world. They can make important savings for you, can also simplify your assemblies. See your Tinnerman representative soon or write to us. **Tinnerman Products, Inc., Box 6688, Dept. 12, Cleveland 1, Ohio.**

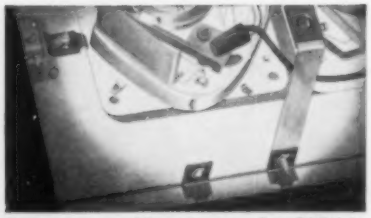
TINNERMAN *Speed Nuts*®

FASTEST THING IN FASTENINGS®



Greater flexibility for control equipment enclosures is provided by self-retaining "J" type SPEED NUTS at 30% less production cost.

Assembly costs on this sheet-metal skylight frame are reduced 66% by Tinnerman "U" type SPEED NUTS.



Gas range assembly costs are reduced 25% to 50% by using Tinnerman "U" and "J" type SPEED NUTS.

Second Annual Get-Together

IN MAY 1956, at Philadelphia, thousands of design engineers and executives attended the first "Design Engineering Show and Conference" ever held. It was of great interest and inspiration. More than 600 were at the conference session held the first day. The audience at the second session was more than 800. The Machine Design Division of the American Society of Mechanical Engineers sponsored the program. More than 1300 registered for the four conference sessions. It was a huge success.

Next May 20 to 23 inclusive the "Second Design Engineering Show and Conference" will be held at the Coliseum in New York City. As at Philadelphia, the show managers will be Clapp & Poliak, the sponsors of the conference will be the Machine Design Division of the A.S.M.E., and the papers committee will be the chief editors of the four leading design publications.

Some progress has already been made in formulating the program. Under the leadership of George Habach, who was appointed Chairman of the A.S.M.E. Machine Design committee and Charles Marks, Chairman of the New York Metropolitan Section of the Machine Design Division, a number of social events have already been planned, including a dinner. Numerous entertainment suites at various hotels will welcome design engineers. There will be many opportunities for "get-togethers" and to make new friends and acquaintances.

Unquestionably, at this Design Show and Conference there will be the biggest gathering of design executives and engineers ever held. Already more than 300 exhibitors have contracted for space. On that basis, it is estimated that more than 2000 engineers will be registered for the conference sessions and the total attendance at the show will be more than 20,000. No other event offers such a splendid opportunity for developing professional interests and contacts in the design field. And likewise, no other show offers the opportunity of seeing and learning so much in so little time about the materials and components that the designer must specify in his bills of materials.

George F. Goodrich

Season's Greetings

GM GENERAL MOTORS

NEW DEPARTURE
BALL BEARINGS

NOTHING ROLLS LIKE A BALL

Colored Finishes for COPPER

A. I. HEIM — Research Engineer
Copper & Brass Research Association

Natural finishes on copper and copper alloys obtainable through combinations of chemical conversion and mechanical treatment of surface; effect of alloy, coloring solutions and treatments; mill produced surfaces, bulk finishing and bright dipping; polishing and buffing.

Copper is the only metal (except gold) having a rich natural color; all other metals are some shade of gray. Also, natural finishes on copper and copper-base alloys offer an unusual range of attractive surfaces, either in the color of the metal itself, or through mechanical or chemical treatment of the surface. The term "finish" as used here concerns solid copper-base alloys in their natural color excluding coatings of other materials such as plated metals or paint.

In dry air a protective film of cuprous oxide, also copper colored, forms on the surface of pure copper; in moist air a "patina" or blue-green basic sulfate forms, or chemical conversion methods may be used on copper or copper-base alloys to develop a variety of blue, black, gold, green and brown shades. When alloyed with zinc, tin or nickel, the color ranges from copper's characteristic red-orange to a tinted gray or silvery white. Grain size, fabricating method and mechanical surface treatments—polishing, buffing and vapor blasting—also affect the finished color. Combinations of alloy and mechanical and chemical treatments thus provide an unusual range of natural color finishes for copper.

A "copper alloy" as defined by the Copper & Brass Research Association contains not more than 99.2 per cent but not less than 40 per cent of copper (as long as the content of copper exceeds any other constituent). Historically, brass is defined as an alloy of copper and zinc; bronze as copper plus tin. In modern terminology, however, brass is considered to be any copper-base alloy in which zinc is the major alloying element, even if small quantities of other elements are also present.

Alloys that are "brasses" by this definition sometimes have names that include "bronze," such as commercial bronze (90 per cent Cu, 10 per cent Zn) because they resemble traditional bronzes in color or because of long usage. True bronzes, containing tin, are today called phosphor bronzes, since phosphorus is added to the melt as a deoxidant. The term "bronze" has also been extended to include certain other alloy systems where the principal alloying element is neither tin nor zinc, such as aluminum bronze and silicon bronze.

Colored Coatings by Surface Conversion

A wide range of colored finishes may be produced on copper-base alloys by surface conversion methods that are mainly chemical in nature. The metal at the surface is converted into a protective film or coating—usually an oxide, sulfide or other compound of the metal involved—or a compound is precipitated which forms a surface film.

Colored coatings on copper, bronze and brass may be produced either naturally or artificially. Aging and weathering cause reactions of free oxygen in combination with moisture to produce oxides or basic sulfates on copper. However, coatings artificially produced, such as shown in Fig. 1 on the next page, are more uniform, thicker, more attractive and offer a wider range of colors than natural film.

Where chemically colored alloys are used, only a thin layer of chemical compound on the base metal is produced at the surface. And because this layer *is* so thin, the character of the finish immediately under it may show through clearly: smooth and lustrous if the metal was originally polished; dull or matte if the metal

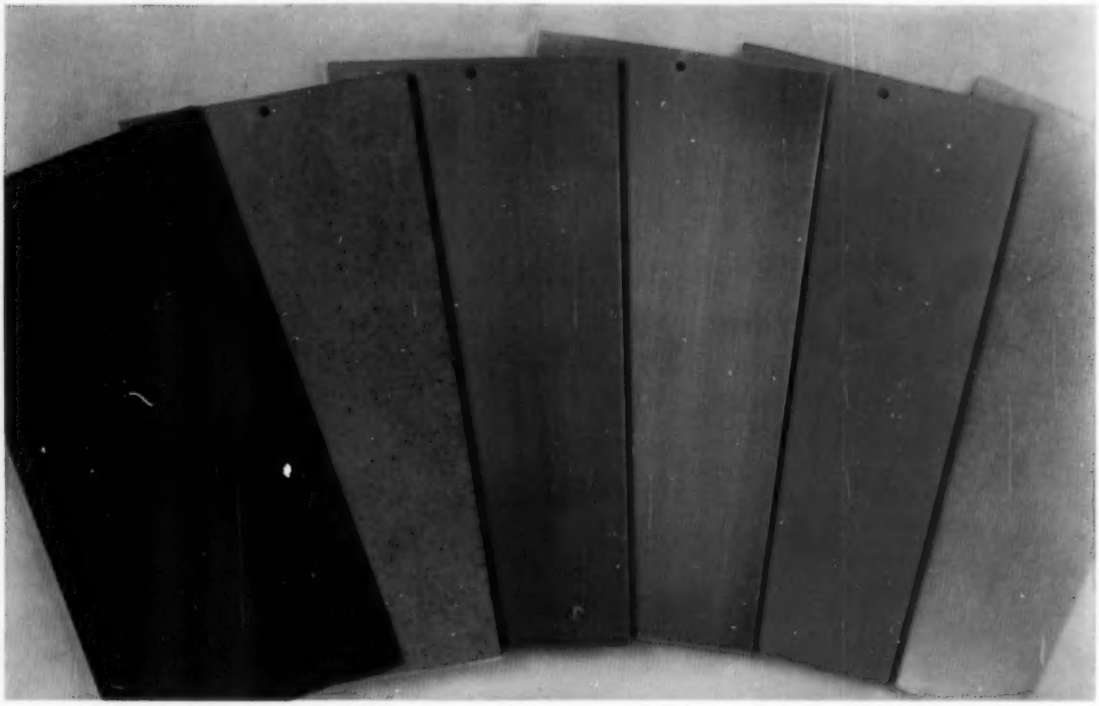


Fig. 1—Color effects obtained by surface treatment on brass. Left to right: verde finishes on red brass, 85 per cent; dark and medium oxidized (statuary) on Muntz metal; dark gold, lacquered; and natural finish on Muntz metal, polished and lacquered.

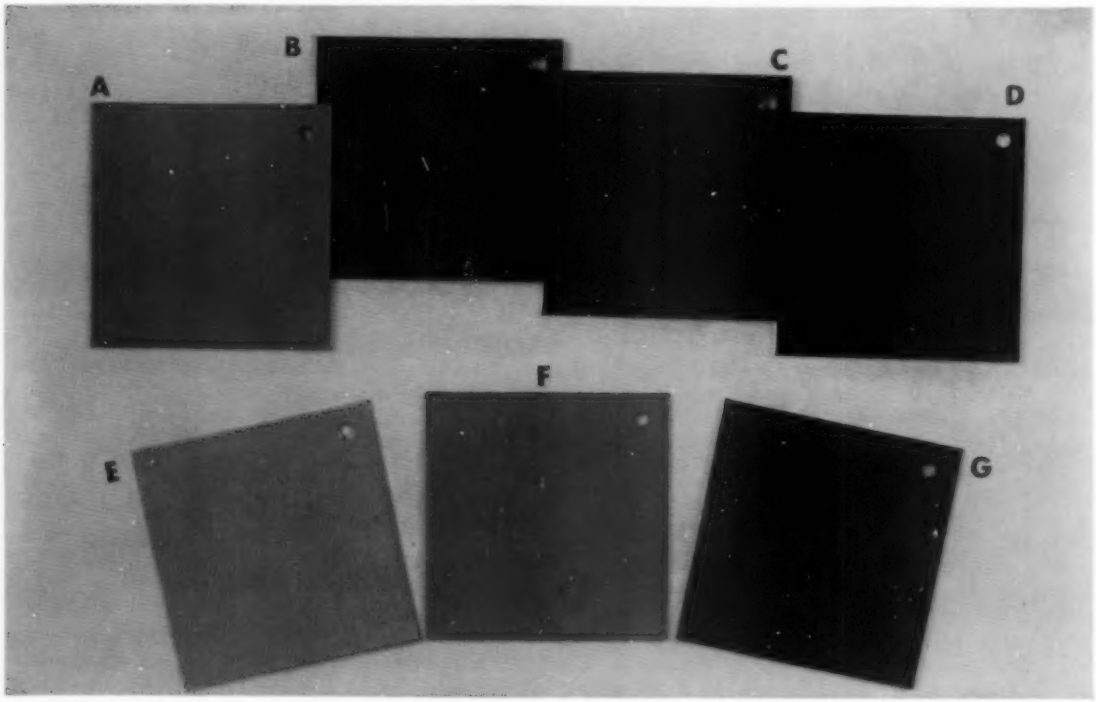


Fig. 2—Dark finishes on red brass (see formulas in text). (A) Light brown produced by copper sulfate with potassium chlorate; for a darker shade (B) a "liquid sulfur" dip is added. Deep blue (C) from sodium thiosulfate and lead acetate. Black (D) is produced by copper carbonate and ammonium hydroxide. Several other shades of brown (E, F and G) are obtained by copper sulfate solutions to which nickel tartarate or ferrous sulfate and acetic acid are added.

has been left unfinished or given a rough finish. Final color tone will also be influenced by such surface treatments as scratch brushing, mottling and highlighting, which in turn depend on the abrasive compounds and the kinds of polishing or buffing wheels used. Small variations in alloy composition can also greatly influence the final color achieved.

Coloring of copper-base alloys is an art—mainly a matter of craftsmanship and experience; and those who work with chemical coatings are inclined to keep their methods secret. Solution formulas must be varied and adjusted to suit particular conditions. Time of immersion in the coloring solution, temperature of the bath and other variables materially influence the final result. In fact, many color effects are obtained by merely varying the procedure and sequence of operations.

Coloring Brass

Many proprietary processes applicable to other metals (cadmium, zinc, iron, steel and aluminum) are also applicable to copper, brass and bronze. In addition, there are literally hundreds of nonproprietary processes for producing various colors on the copper alloys. Methods suggested here are ones which those experienced in this field have found to be reliable. But a willingness to experiment, patience, and many tests are necessary to develop desired colors. It is recommended that work be done experimentally on sample strips or small areas under conditions approximating those to be encountered in full-scale application. For satisfactory results the base metal must be clean, ingredients must be pure, and proportions mixed accurately.

Some of the more common color effects and the formulas for obtaining them are:

BROWN—A wide range of browns are produced by solutions based on copper sulfate. The light brown shown at (A) in Fig. 2 is obtained by:

Copper sulfate, crystal	4 oz
Potassium chlorate	8 oz
Water	1 gal

The work is immersed for a minute or so, and rinsed in cold water. Dry by using hot water and sawdust, and scratch brush dry.

A darker brown (B) can be obtained by going from this solution (without rinsing) to a solution of 1 oz "liquid sulfur" to 1 gal of water. If color is not dark enough, repeat both dipping operations. Dry as before.

BLUE—A deep blue color shown at (C) is developed by:

Sodium thiosulfate	8 oz
Lead acetate	4 oz
Water	1 gal

Use at boiling temperature and immerse just long enough to produce blue color.

BLACK—The following solution works successfully on brasses containing from 20 to 30 per cent zinc, producing a color as shown at (D).

Copper carbonate	1 lb
Ammonium hydroxide	1 qt
Water	3 qt

Add the water after the copper carbonate and the ammonia have been thoroughly mixed. Use at a temperature of 175F, and immerse work until the color is obtained (usually from ½ to 1 min). There must be excess copper carbonate. Use as near the boiling point as possible. Scratch brush dry. If the color is not dark enough, pass through a dip composed of 2 oz of sulfuric acid and 1 gal of water.

Several other variations in brown shades can be produced. For a light brown (E) parts may be immersed in "liquid sulfur" solution for a minute or so, and then without rinsing, immersed into a solution of:

Sulfuric acid	1 oz
Nitric acid	1 oz
Water	1 gal

If color is not dark enough, repeat both dipping operations and scratch brush dry.

A darker brown (F) is obtained with the copper sulfate solution used in (A) to which nickel tartarate is added; or for the still darker brown shown at (G) ferrous sulfate and acetic acid are added.

ANTIQUE—Apply an arsenic deposit from:

Arsenic trioxide	10 oz
Sodium cyanide	8 oz
Sodium hydroxide	10 oz
Water to make	1 gal

Relieve with pumice and water; brighten with sodium bicarbonate. The arsenic may also be deposited from an acid solution:

Arsenic trioxide	20 oz
Copper sulfate, crystal	10 oz
Hydrochloric acid	1 gal
Temperature	120 F

OLD ENGLISH FINISH—Two solutions are necessary for this finish:

(1)	"Liquid sulfur"	½ oz
	Water	1 gal
(2)	Copper sulfate, crystal	2 oz
	Water	1 gal

The work is thoroughly cleaned in an alkaline cleaning solution, then dipped in solution (1) and without rinsing dipped in solution (2). These dips are only momentary. Rinse in clean cold water and repeat dipping operations until a light color is produced. For an even finish, scratch brush dry and repeat dipping operations, and finally scratch brush dry.

PATINA—A variety of green, verde or patina colors can be produced on brass. The parts are immersed in a room-temperature solution of:

Copper nitrate	3 oz
Ammonium chloride	6 oz
Calcium chloride	5 oz
Water	1 gal

After the color is formed, parts are removed and dried.

TIFFANY GREEN—Use a solution of:

Copper sulfate	8 oz
Ammonium chloride	4 oz
Sodium chloride	4 oz
Zinc chloride	1 oz
Acetic acid	2 oz
Water	1 gal

The addition of 1 oz of glycerine will prevent the green from drying too fast and helps produce a more even color. This solution is used for immersion and if the color is not uniform, dipping may be repeated as many times as desired, allowing the work to dry thoroughly between dips.

VERDE FINISHES—Three solutions for developing verde on brass:

(1)	Hydrochloric acid	½ qt
	White arsenic	4 oz
	Copper acetate	1 lb
	Copper carbonate	¼ lb
	Ammonium chloride	1 lb
	Water	1 gal

Dissolve the arsenic in the hydrochloric acid with the aid of heat and then add the copper carbonate. Dissolve the copper acetate and the ammonium chloride in the water and mix the two solutions thoroughly.

This is used with a brush. If desired as an immersion solution, use twice the volume of water.

(2)	Copper nitrate	4 oz
	Ammonium chloride	4 oz
	Copper acetate	4 oz
	Water	1 gal
(3)	Copper nitrate	8 oz
	Ammonium chloride	4 oz
	Acetic acid	4 oz
	Chromic acid	1 oz
	Water	1 gal

Apply lightly with a brush and let dry. If finish is not even, brush again with the solution and let dry.

Coloring Copper

A wide range of colors can also be produced on pure copper.

LIGHT TO DARK BROWN—Alkaline cleaning baths are frequently used for producing various shades of brown. Repeated immersions and scratch brushing are necessary to obtain desired tones. Both the concentration and composition of solution are important. Usually solutions strong in caustic soda are used. Brown color effects can also be obtained on most of the standard copper alloys by this method. Two solutions giving a range of brown colors are:

(1)	Copper sulfate	5½ oz
	Potassium chloride	2¾ oz
	Water	1 gal
	Temperature	140 F

Brush wet with a fine brass wire brush; repeat operations if necessary.

(2)	Copper sulfate	4 oz
	Potassium chlorate	1 oz
	Water	1 gal
	Temperature	170 F

Scratch brush wet; repeat coloring operations if finish is uneven.

BROWN TO BLACK—Depth and shade of color, with the following solution, depends upon time of immersion.

Potassium sulfide	1 oz
Aqua ammonia	¼ oz
Water	1 gal
Temperature	70–80 F

Dry and scratch brush with fine brass wire brush.

BLACK—Scratch brush wet, and immerse in the following solution unil a uniform black color is obtained:

Arsenic trioxide	4 oz
Hydrochloric (conc)	8 oz
Sulfuric acid	2 oz
Water	1 gal
Temperature	180 F

For bright-dipped or polished surfaces a deep black color is obtained without brushing by:

Ammonium hydrosulfite	2¼ oz
Potassium sulfide	1 oz
Water	1 gal
Temperature	Room cold

Many of the colors produced on copper and copper alloys are not permanent or light-fast. It is generally considered good practice to protect these finishes with a clear organic coating such as lacquer or shellac.

Mill-Produced Surfaces

A desired surface effect can often be obtained simply and at low cost by specifying a standard mill shape. For example, if the part can be sawed from a hexagonal solid rod or extruded shape, no further surface treatment, other than polishing, may be needed. Typical mill shapes include rounds, hexagons, rectangular, oval, or special drawn or extruded shapes.

Where the part is to be subsequently worked, as in spinning or cold forming, the composition and temper can be adjusted to provide better ductility. But, in general, the copper-zinc alloys are easily worked and designs produced on them are sharp.

Embossed and patterned metal surfaces on sheet copper-base alloys, Fig. 3, are supplied by brass mills in a wide variety of designs in stock patterns on a range of brasses and bronzes, and some nickel silvers. Furnished in the form of flat strips or rolls, metal thickness varies from 0.010 to 0.064 in. depending on pattern. Standard embossings include: simulated hammer marks, concave or convex, large or small; diamonds, stripes, arabesque, bark, corrugated, oak leaves, moire, wavy lines, basket weaves, herringbone, shells, starts, pebble effects. Unusual designs can be made to special order.

Grain size of the material has an important influence on the final appearance and the finishing operations to use. During annealing, the grains increase in size: a low annealing temperature or short annealing time will yield a small grain size—in the order of 0.015 mm; a high temperature or longer annealing time will increase grain size to 0.090 mm or larger. The grain size best suited for a particular application will depend on thickness of metal and fabrication method being used. For example, sheet brass having greater than 0.050 mm grain size will show an "orange peel" effect when deep drawn, and this surface roughening will require relatively expensive finishing operations to remove. A grain size of 0.025 mm would require less finishing.

Bulk Finishing

To produce a bright finish on large volumes of copper and brass parts two or more processes may be used

Table I—Bright Dipping and Pickling Solutions

	Bright Dip	
A	Sulfuric acid	2 gal
	Nitric acid	1 gal
	Water	1–2 qt
	Hydrochloric acid	½ fl oz
	Temperatures	Room
B-1	Nitric acid	1 gal
	Water	1 gal
B-2	Nitric acid	1 gal
	Sulfuric acid	1–2 gal
	Water	1–5 gal
C	Sulfuric acid	12 oz
	Sodium dichromate	8 oz
	Water	1 gal
	Temperature	Room
	Matte Dip	
D	Sulfuric acid	2 gal
	Nitric acid	1 gal
	Zinc oxide or zinc sulfate	Supersaturated
	Temperature	180 F
E	Hydrochloric acid	1 gal
	40 deg ferric chloride solution	1 gal
	Polishing	
F	Water	100 parts
	Chromic acid	12.5 parts
	Sodium dichromate	37.5 parts
	Acetic acid	12.5 parts
	Sulfuric acid	10 parts
	Pickling	
G	Sulfuric acid (1.84 spec gr)	½–1 gal
	Water	9 gal
	Temperature	Room to 150 F
H	Sulfuric acid	13 oz
	Ferric sulfate	13 oz
	Water	1 gal
	Temperature	
	Low copper alloys:	120–140 F
	High copper alloys:	140–175 F

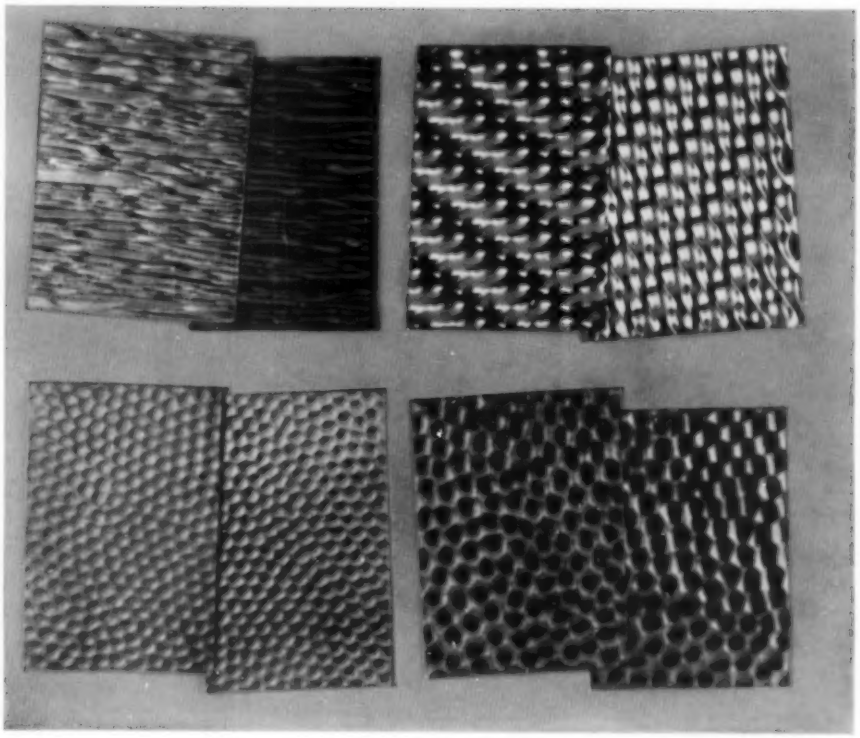


Fig. 3 — Four textured surfaces each on copper and brass—representative of the variety of surface patterns obtainable.

—first, to condition the surface and, second, to give the finished appearance. A finish on copper-base alloys entirely satisfactory for many purposes can sometimes be obtained by mechanical cleaning, ball burnishing or other simple abrading operations. Methods in common usage include:

Barrel Finishing or Tumbling. Small size castings, forgings, stampings and drawn or upset parts may be finished in rotating or tilting barrels partially filled with abrasive material such as powdered pumice, sharp sand, iron slugs, or steel balls, together with caustic soda flakes, sodium cyanide and water. Rotating speed is 20-60 rpm. This method provides an excellent surface for subsequent buffing or polishing but is not well suited for relatively fragile articles; deep depressions or high projections interfere with the process.

Ball Burnishing. This refinement of barrel tumbling produces the highest luster that can be obtained on small objects by bulk finishing methods. Work is rotated in horizontal or oblique barrels at about 30 rpm for 6 to 48 hr, depending on degree of luster desired. Tumbling material is "neutral" soap, cream of tarter or its equivalent, and soap bark. For each volume of work, two volumes of steel polishing balls or other shapes ⅛ to ½ in. dia are used. Barrels are filled with water to within a few inches of the cover, and 2 oz of soap added for each gallon of water. The work is dried in a horizontal barrel containing sawdust mixed with a safety solvent. For best results work should be deburred and bright dipped before burnishing.

Bright Dipping. Bright dipping of copper and brass makes the metal surface brighter but does not remove mechanical imperfections. It is often used to prepare a surface for later finishing treatments, and usually consists of sulfuric acid and nitric acid in varying proportions plus a small quantity of water and hydrochloric acid. A typical formula is given in (A), Table I. An excess of hydrochloric acid in this solution may tend to cause spots to appear on brass. To counteract this, a solution of sodium chloride sometimes replaces hydrochloric acid in this formula, or wood soot and activated carbon may be added.

If the workpiece is coated with scale it should be treated in a "scaling dip" before bright dipping. Two usual formulas are given in (B), Table I. After bright dipping and rinsing in cold running water, any stains remaining on the work may be removed by dipping in a solution of 4 oz sodium cyanide per gal of water, and thoroughly rinsed in clean water. **Caution:** bright dipping fumes are toxic and the acids are dangerous.

Where a semi-bright finish is satisfactory, dichromate dip, formula (C), is less expensive and more convenient to use.

Matte Dipping. To produce a light matte finish on copper and its alloys after bright dipping, rinse thoroughly, then dip in a weak solution of sodium cyanide, rinse again, and *dry thoroughly*. The work is then dipped in the solution given in formula (D). Work should be kept in the solution until all action ceases. The solution is used at about 180 F, occasionally stirred with a wooden paddle, and must be kept free of water. A greater concentration of nitric acid will coarsen the finish; a greater amount of sulfuric acid will make the finish

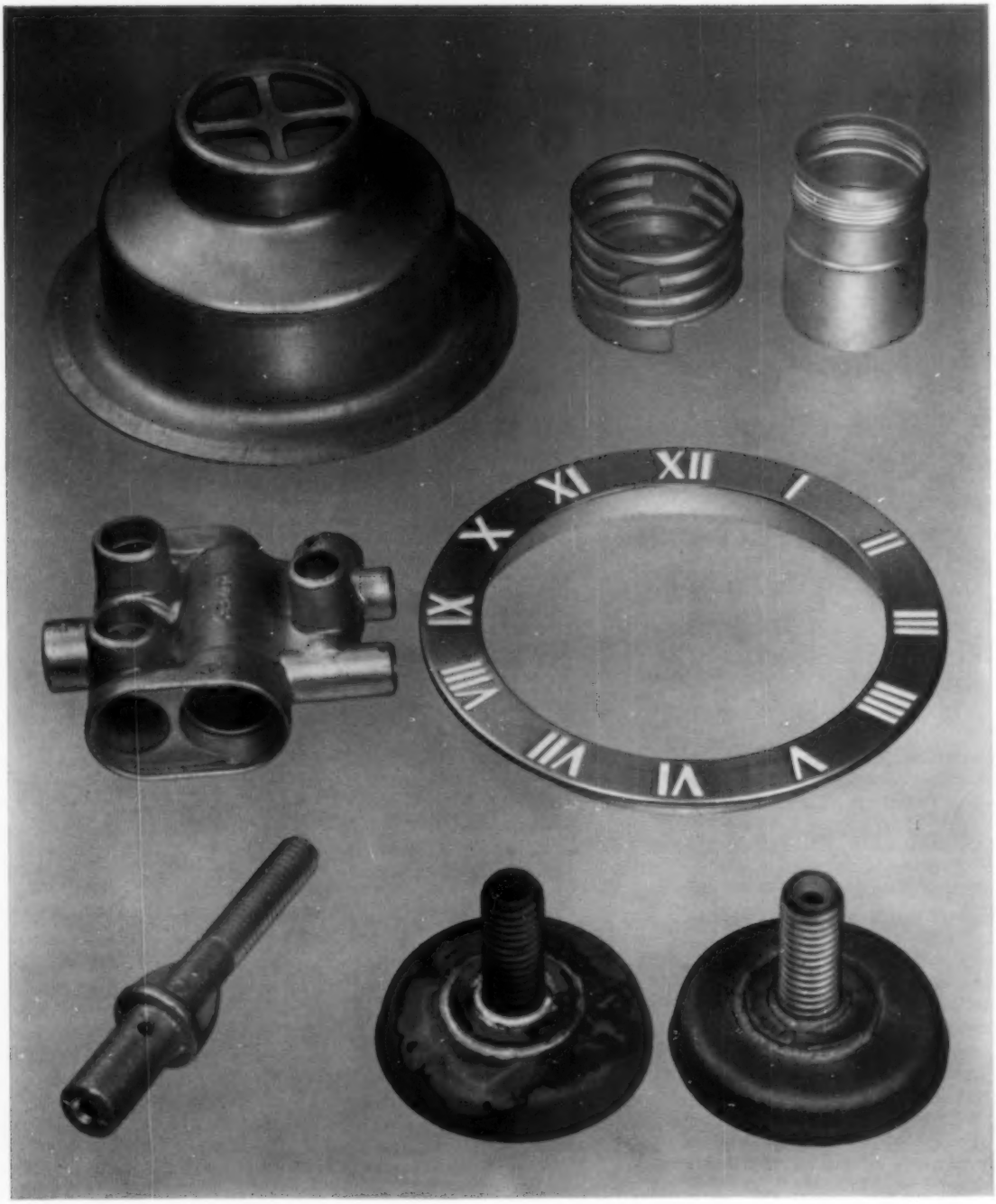


Fig. 4—Natural color of representative copper alloy parts. Forged sink drain is 60 Cu, 38 Zn, 2 Pb, selected for good forging properties and attractive color; finished by a weak acid pickle and used with natural finish.

Lamp bases with rolled threads. Left, deoxidized copper bright-dipped to bring out the color; right, fine grain 70-30 brass colored by buffing with rouge.

Forged brass valve body bright dipped in heavier acid concentration to produce a more reflective surface; brightness is also affected by the forging temperature.

Clock bezel stamped from red brass sheet. Alloy was selected for good cold working as well as for a natural golden color; finish obtained by bright dipping, with paint applied and wiped off; after drying the bezel was polished and wire brushed to a satin finish and lacquered.

Copper forging for transformer terminal (shown at lower left) was tumbled and then sand blasted to accentuate the deep color of pure copper.

Brazed copper terminals before and after bright dipping to restore the natural copper color.

finer. After the above operation the work must be rinsed, bright dipped, rinsed and dried.

A very dull finish may be obtained by etching copper or its alloys at room temperature in formula (E). After etching, parts are rinsed in cold water and briefly immersed in a dichromate dip to remove smut.

Electrolytic Polishing. Articles to be polished are made the anode in an electrolyte designed to produce finishes ranging from a light matte, through semi-luster, to a bright polish. Surfaces polished by this method are generally free from mechanical stresses and have no embedded abrasive particles. No special operations are required to prepare the surface and only a rinse in cold running water is needed after the work has left the bath. Commercial electrolytic polishing bath solutions are acid in nature. Formula (F) is a typical solution (U. S. Patent No. 2,330,170).

Acid Pickling. Pickling is primarily used to remove oxides which develop on a copper alloy as a result of annealing. The pickling operation is generally performed with common commercial acids such as nitric, sulfuric, and hydrochloric. Formula (G) is a frequently used pickle. For heavier scale, the solution is more concentrated and used hotter.

Sometimes the addition of an oxidizing agent is desirable to remove the red stain due to oxide films on brass and bronze. In such cases either sodium dichromate or ferric sulfate is added to the acid. Typical solutions are dichromate dip, formula (C), and ferric sulfate pickle, formula (H). Use the lowest concentration of chemicals that will produce the desired finish. (The ferric sulfate is first dissolved completely in a small quantity of water, heating the water if necessary.) If the solution is too strong, or if the work is left in the pickle too long, pitting and etching may result. If used properly, the solution should give a clean, natural, non-glossy surface. After pickling, objects must be well rinsed, and if necessary, treated with neutralizer to remove traces of acid.

Blast or Vapor Cleaning. These processes call for bombardment of the metal surface with particles striking at speeds of 250-350 ft per sec. Particles may be flung by centrifugal force from a rapidly rotating wheel or shot from a nozzle by compressed air or steam. Depending on the finish desired, particles may have varying degrees of hardness and abrasive quality, such as coffee grounds, rice husks, cocoanut shell meal, various kinds of seeds and plastic powders. Vapor blasting utilizes much higher speeds (3200 ft per sec tip velocity) and the abrasive materials, mixed with water, are much finer.

Grinding, Polishing and Buffing

There is no clear dividing line between these three processes. Nor can they be classified as exclusively "conditioning" or exclusively "finishing" processes. Basically, the terms mean the same thing: employing the cutting action of an abrasive material to smooth or polish the surface. The abrasive may be distributed on the surface of a rotating wheel, a fast moving belt, or the work itself may be rotated against a stationary abrasive. Essential difference between the three methods is more a matter of variation in detail than of basic principle of operation.

Grinding. Employs rigid wheels or belts containing coarse abrasives. Surface speed of emery wheels or bobs is usually about 4000-5000 ft per min. This operation is useful for rough finishing: removal of scale, as well as fins and gates remaining on brass and bronze castings. Variation: sand-bobbing, using a coarse abrasive wet down with mineral oil to keep down dust, is useful on softer metals which tend to clog the surface of a grinding wheel.

Polishing. Employs softer wheels than grinding, and the abrasive is glued or cemented to the working surface of the wheel. Grade of abrasive and composition of wheel depends on depth of surface imperfections. For very rough surfaces several wheels of various grades may be used in succession. Polishing wheels are run at surface speeds of 6000-9000 fpm. (If fine-grained material is used, the polishing operation can be eliminated in some instances.)

Buffing. This is a refined polishing operation utilizing relatively soft abrasives and wheels. Wheels may be ventilated, or have pleats to hold the abrasive. Buffing is sometimes regarded as a two-stage finishing operation. In the first stage, called "cutting down" a light abrading action is sought. The second stage, called "coloring" or "color buffing" produces the final high finish or luster. Buffing wheel surface speeds vary from 6000-8000 fpm.

Mirror finishes are obtained by buffing. Abrasives include rouge (red ferric oxide), crocus (purple ferric oxide), tripoli or lime. It is common practice to mix these abrasives with stearic acid and tallow, and form a cake or bar which is pressed intermittently against a revolving wheel. Another common method is to spray liquid polishing and buffing compounds on the wheel.

Brushing. Work is held against revolving metal wire or Tampico fiber brush wheels with or without an abrasive. A wheel of soft brass wire, with a lanolin emulsion or soluble oil as lubricant, may also be used. Action produces a texture made of parallel lines, uniformly deep and uniformly wide. Variation: Satin or Butler finishes, which give a copper alloy surface a velvety appearance, are produced with polishing wheels made up of quick-drying glues carrying graded abrasives or "greaseless" compounds. No sticky or greasy residue is left on the work.

Generally, the terms "brushed" and "Tampico" denote fairly fine lines; "Butler" and "Satin" still finer lines, "scratch-brush" and "wire brush" relatively coarse lines. Lined finishes are considered "dull." And by manipulating the wheel or the article being finished, lines may be caused to run in any direction for specific light-reflecting characteristics.

Natural Copper Alloy Colors

Copper-base alloys in their natural colors, Fig. 4, can offer a wide choice of pleasing tones and shades. Color selections range from red to gold to yellow to silvery white, depending on the composition. In the brasses (copper-zinc series) the reddish-orange of pure copper persists until about 5 per cent zinc content.

As more zinc is added the tone lightens, until at 10 per cent a typical bronze shade is produced. At about 15 per cent zinc content, brass exhibits a warm reddish-gold color. Increasing the zinc causes a yellow

Table II—Compositions for Color Matching Copper Alloys

Rich Bronze—If a warm, bronze color is specified, commercial bronze (90 Cu, 10 Zn) can be used for wrought parts. In general, drawn shapes and sheet parts formed from this alloy will match closely. Mill shapes available include tube, bar stock, and drawn moldings. However, if commercial bronze are extruded they will not match the color of drawn shapes in commercial bronze. If a cast component is to be used, the composition should be 86 per cent copper, 8 per cent zinc, 4 per cent tin and 2 per cent lead.

Red-Gold or Typical Bronze—Sheet and tubular shapes of red brass (85 Cu, 15 Zn) will provide a satisfactory "typical" golden bronze. Extruded shapes to match this color should be formed from a leaded brass containing nominally 55-58 per cent copper, 2-3¼ per cent lead, and the balance zinc. Cast parts to match the extrusions should be 83 per cent copper, 11 per cent zinc, 4.5 per cent tin and 1.5 per cent lead.

Silvery Blue-White—When a brilliant silver color is required, a special alloy of 75 per cent copper, 20 per cent nickel and 5 per cent zinc may be specified for rolled, drawn or tubular shapes, bars or sheet. A casting alloy to match would consist of 64.5 per cent copper, 20 per cent nickel, 3 per cent tin, 5 per cent lead, and 7.5 per cent zinc.

White or Silver—For parts made from sheet, tube, bars, rods and other drawn or rolled shapes use a nickel-silver containing 55.5-58.5 per cent copper, 15 per cent nickel, remainder zinc. For extruded shapes use a leaded nickel-silver with 40.5-43.5 per cent copper, 12-14 per cent nickel, lead not exceeding 1 per cent, balance zinc. A casting alloy to match will contain 52-53 per cent copper, 20 per cent zinc, 16 per cent nickel, 4 per cent tin, 6-7 per cent lead, other impurities 1 per cent.

Yellow-White—Nickel-silver 65-10 (65 Cu, 25 Zn, 10 Ni) is suitable for wrought shapes: sheet, seamless tube, bars, rods, etc. Extruded parts to match can be fabricated from a leaded nickel-silver containing 52-53 per cent copper, 38-39 per cent zinc, 8-10 per cent nickel, 1-1.5 per cent lead. A suitable mixture for cast parts contains approximately: 55 per cent copper, 20 per cent zinc, 12.5 per cent nickel, 10.5 per cent lead, 2 per cent tin.

golden color at 20 per cent, a brassy yellow at 30 per cent and a bright yellow at 35 per cent.

At about 38 per cent zinc content, however, a reversal of this behavior takes place. Brass ceases to become lighter as zinc is added, and starts to take on a red cast. Thus, Muntz metal (60 per cent Cu, 40 per cent Zn) is best described as having a golden-buff-red color.

In alloys containing tin, such as manganese bronze or phosphor bronze, the alloy color generally tends to become lighter in direct proportion to the amount of tin added. The copper-tin series (or tin-bronzes) therefore range in color from copper-red, through dark bronze, to light bronze as tin content is increased:

Alloy	*Zinc, per cent*	*Color*
Pure copper	0	Reddish-orange
Gilding metal	5	Copper red
Commercial bronze	10	Typical bronze
Red brass	15	Reddish gold
Low brass	20	Yellow gold
Cartridge brass	30	Brassy yellow
Yellow brass	35	Bright yellow
Muntz metal	40	Golden to bluff red

Two silicon bronzes deserve special mention. The color of high-silicon bronze, which has a nominal silicon content of 3 per cent, is approximately the same as a 5 per cent tin-bronze. The low-silicon bronze, which has a nominal 1.5 per cent silicon, resembles pure copper in color.

The nickel silvers, although they contain no silver, do exhibit varying shades of silvery color. These copper alloys contain different percentages of nickel and zinc, and sometimes small amounts of lead. Alloys of the series may have more nickel than zinc, or more zinc than nickel. But, in general, nickel is added to copper-zinc for its influence on color.

When nickel content is high, metal color is silvery white. As the nickel component is reduced, the color becomes less brilliant. When nickel is low, the alloy takes on a yellow-white cast. The nickel silver series should not be confused with the cupronickels, which are composed of copper and nickel but no significant amount of zinc.

Except where special mechanical and physical properties inherent in the copper-tin alloys are required, colors satisfactory for most applications can be obtained by using alloys of the copper-zinc series for brass or bronze tones, and nickel-silvers for variations of silver-white.

Effect of Fabricating Methods

When several copper-base alloy parts are used in an assembly and must be closely matched in color, there is no problem if all components are produced by the same method of fabrication. But the final color may be noticeably different when some alloys of identical composition are subjected to rolling, extruding or drawing. Annealing may also change the color, and in addition, the compositions of casting alloys are usually different from wrought alloys in order to adapt them to foundry requirements. In most cases, nonstandard alloys must be used for wrought products when parts fabricated by extruding or casting must be color matched. Table II gives the compositions for color matching copper alloy shapes fabricated by different methods, as recommended by specialists in this field.

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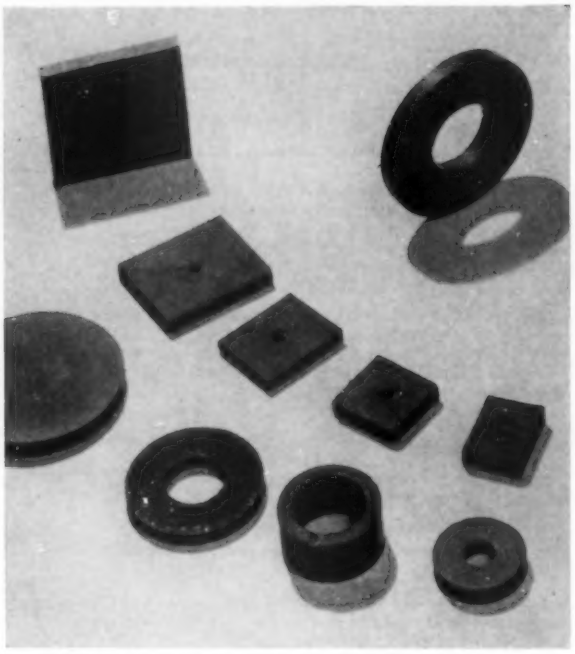

Barium ferrite ceramic magnets pressed from powder. Unusually high coercive force makes them suitable for applications in which operating point and flux density of the magnet changes appreciably during use, such as in holding assemblies, magnet torque drives, and generators. Although Alnico V produces field energy over five times that of the ceramic magnet, potential energy of ceramic magnet is substantially greater.

NOMENCLATURE

General Terms

A — area of magnetic field, in.^{2}
Am — area of magnet, in.^{2}
B — flux density, or gauss
E — energy, in. lb
e — instantaneous emf applied to pure inductive solenoid, volts
H — magnetizing or demagnetizing force, oersted
i — instantaneous current through pure inductive solenoid, amp
L — length of magnetic field, in.
Lm — length of magnet, in.
N — number of turns
R — total circuit resistance, ohms
t — time, sec
ϕ — flux in maxwells or lines
u — permeability or B/H

Points on Major Demagnetization Curve

d — general point
d_1 — max energy-product
d_2 — max potential energy
d_3 — max practical potential energy

Points on B Axis

k — general point originating at d
k_2 — point originating at d_2
k_3 — point originating at d_3
r — residual magnetic induction

CERAMIC MAGNETS

How barium ferrite magnets compare with Alnicos; how to utilize the high coercive force and potential energy of ceramic magnets; holding, driving and generator applications.

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STRENGTH OF PERMANENT-MAGNET MATERIAL is considered to be proportional to its maximum energy-product. Strength of a permanent magnet is considered to be proportional to its operating energy product. These concepts have resulted in the efficient design of permanent magnets and assemblies using the Alnicos. However, with ceramic magnets modification of older concepts is required to utilize full capabilities of these new magnets in applications such as holding assemblies, and hysteresis drives.

For example, if a fully-magnetized Alnico magnet is subjected in operation to demagnetizing influences which reduce the flux density substantially lower than that at the peak energy-product point, flux density is permanently reduced and can only be regained by remagnetizing. Ceramic magnets, however, can be operated at low or even negative flux densities, yet retain the ability to produce maximum flux when the demagnetizing influence is removed. Because of this, ceramic magnets are frequently more economical than Alnico V, the strongest commercial permanent magnet material. General characteristics of

Table I—Comparison of Ceramic and Alnico Permanent Magnet Materials

Materials	Characteristics	Typical Applications
Barium ferrite ceramic	Strong resistance to demagnetization where operating air gap varies.	Polarized transducers; TV focusing units; holding assemblies for toys, novelties, cabinet latches; synchronous drives.
Cast Alnicos V	Highest energy of any commercial material.	Meters; speakers; radar magnetron magnets; separators; magnetos.
I	Magnetically similar to Alnico III, but can be cast in larger sizes.	Large magnets producing uniform field strength over large area.
II	Highest energy of non-oriented Alnicos; good for small sizes and shapes, difficult or impossible to properly orient.	Small multi-pole generator and magneto rotors.
III	Only Alnico material with no Cobalt; non-oriented; practical sizes limited.	Small holding magnets in toys and novelties.
IV	Superior to non-oriented Alnicos when operated at low flux density.	Generator rotors.
VI	High energy oriented material superior to Alnico V when operated at low flux density; physically stronger than Alnico V.	Generator and magneto rotors; holding magnets.
Sintered Alnicos II, IV, V, VI	Magnetic properties somewhat inferior to cast Alnicos; physically stronger than cast Alnicos, superior appearance; can be held to closer tolerances without grinding; shapes and sizes limited.	Small holding magnets in toys, novelties, snap action switches; generator rotors.

Table II—Characteristics of Barium Ferrite Ceramic Permanent Magnets

Material	$BaFe_{12}O_{19}$; ceramic; hard and brittle; no critical ingredients
Density	0.17 lb/in³
Resistivity	10^6 to 10^7 ohm/cm³
Fabrication	Pressed from powder; can be ground to close tolerance.
Application	Mounting with adhesive recommended
Magnetization	20,000 amp turn/in. required
Magnetizing Characteristics	Superior in direction of pressing
Resistance to Demagnetization	Exceptional; permits magnetizing before assembly without reducing magnetic energy; remains permanently fully magnetized with poles located as desired; demagnetized by heating to 450 C
Magnetic Energies	Efficient in short magnetic lengths, and large magnetic areas

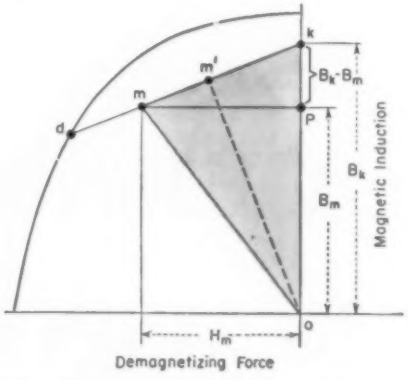


Fig. 1—General demagnetization curves.

the Alnicos and barium ferrite ceramic magnets are compared in Table I.

Barium ferrite ceramic magnets, characteristics of which are given in Table II, have a maximum energy product of approximately 0.95 x 10^6 gauss-oersted per cm³ compared to 5.25 x 10^6 for Alnico. Consequently, a given volume of Alnico V can produce a field energy approximately 5.25/0.95 or 5.5 times that of a ceramic magnet of the same volume. However, because of their strong resistance to demagnetizing influences, ceramic magnets can store more potential energy per unit weight than other commercial magnetic materials.

Useful Magnet Energy

Potential energy of a permanent magnet exists both in the field and internally. This internal energy is extracted and replaced by the variation in demagnetizing forces occurring over an operating cycle, such as is indicated in Fig.1. Assuming this magnet is used in a holding function, flux density B_m is a maximum when demagnetizing force H_m is zero at point **k**; this is approached when the magnet poles are in intimate contact (zero air gap) with a mild steel armature. As the magnet is pulled away from the armature, flux density drops to minimum operating flux B_m at point *m*.

POTENTIAL ENERGY IN A MAGNET

The amount of energy in a magnetic field can be derived, in in.-lb, from analysis of the magnetic field of a toroidal air-core solenoid connected as shown in the accompanying circuit diagram. The magnetic field of such a toroid is confined within itself; consequently, kinetic energy entering the coil is stored in the field as potential energy. The value of this energy E in a field of flux density B and volume $A\ L$ can be obtained by determining total kinetic energy absorbed from the time the switch is closed at $t = 0$ to that time $t = t$ when current flow and magnetic field reach a static maximum value. Beyond this time, current flowing in the circuit does not further increase stored magnetic energy but is wasted in the form of heat losses in the circuit resistance.

At any given instant after the switch is closed, kinetic energy entering the solenoid is the product of voltage e and current i, in watts. Total stored potential energy E from $t = 0$ to $t = t$ is the integral of input power ei with respect to time, in watt sec; since 1 watt sec equals 8.85 in.lbs,

$$E = 8.85 \int_{t=0}^{t=t} ei\ dt \text{ in. lb} \qquad (1)$$

To solve Eq (1), e and i are evaluated in terms of given circuit quantities.

$$e = N\ d\phi/dt\ 10^{-8} \qquad (2)$$

Flux ϕ is equal to 6.45 $A\ B$; change in flux $d\phi$ is equal to

$$d\phi = 6.45\ A\ dB \qquad (3)$$

Substituting in Eq (2)

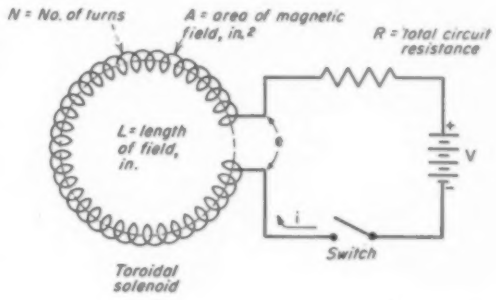
$$e = 6.45\ N\ A\ dB/dt \qquad (4)$$

The magnetizing or mmf force per unit length in the solenoid is Ni/L amp turns per in. Converting units, field strength or total magnetizing force H, in gilberts per cm, is equal to $0.4\pi Ni/2.54\ L$, and i is equal to $2.54\ LH/0.4\pi N$. The torodial solenoid has an air core, so permeability or B/H is 1 and B is substituted for H. Therefore

$$i = 2.54\ L\ B/4\pi N \qquad (5)$$

Substituting the value of e from Eq (4) and i from Eq (5) into Eq (1) and evaluating the integral:

Potential energy stored in a magnetic field is



$$E = 0.577 \cdot 10^{-8}\ BA\ HL \text{ in. lb} \qquad (6)$$

When a permanent magnet produces an external field, this field mmf or HL, is equal to the mmf or H_mL_m of magnet flux B_mA_m, therefore:

Energy stored in a permanent magnet field is

$$E = 0.577 \cdot 10^{-8}\ B_mA_m\ H_mL_m \text{ in. lb} \qquad (7)$$

and is proportional to area *omp* in Fig. 1

Field energy produced per cu in. of permanent magnet material is

$$E/A_mL_m = 0.577 \cdot 10^{-8}\ B_mH_m \text{ in. lb} \qquad (8)$$

Specific weight of a magnet material is w (lb/in.³) or $1/$ (w in.³), so:

Field energy produced per lb of permanent magnet is

$$E/w = (0.577/w)\ 10^{-8}\ H_mB_m \text{ in. lb/lb} \qquad (9)$$

In addition to energy in the external field, a permanent magnet also has internal energy; it can be shown that:

Internally stored energy is equal to

$$E = 0.577 \cdot 10^{-8}\ (B_k - B_m)\ A_mH_mL_m \qquad (10)$$

where (B_k—B_m) is the change in flux density as the magnet is operated from point m to point k of Fig. 1, and is proportional to area *mkp* of Fig. 1 when (B_k—B_m) is the change in flux density as the magnet is operated from point *m* to *k*. Adding Eqs (7) and (10):

Total potential energy of a permanent magnet is

$$E_{tot} = 0.577 \cdot 10^{-8}\ B_kA_m\ H_mL_m \qquad (11)$$

and is proportional to the area *omk*.

Total potential energy in this magnet, from Eq (7), is: $E = 0.577 \cdot 10^{-8}\ (H_m\ L_m\ B_k\ A_m)$. The slope of demagnetization curve *dk* is linear, and potential energy at point *m* is proportional to area *omk*. For a partial operating cycle, magnet energy supplied in going from point *m'* to *m* is equal to $0.577.10^{-8}\ B_k\ A_m\ (H_m - H_{m'})\ L_m$ and is proportional to area *om'm*. Maximum available energy is obtained by extending the operating cycle from a point *m* to d_2, which is at max potential energy.

Specific values of maximum flux variation and demagnetization force needed to obtain maximum degree of potential energy from ceramic and Alnico magnets are

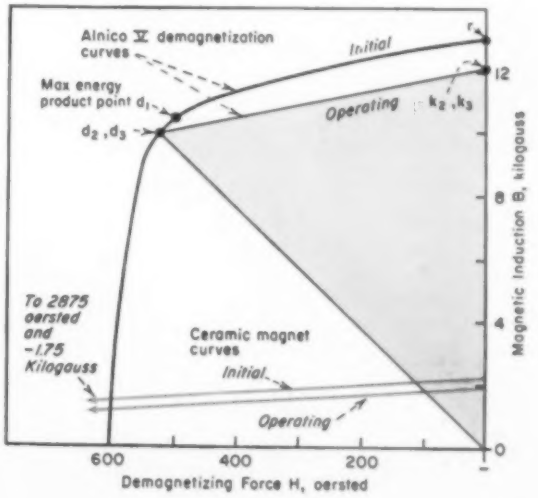


Fig 2—Alnico *V* demagnetization curve. Points of maximum potential energy *d*2, and maximum practical potential energy *d*3 coincide. Colored area is proportional to maximum potential energy. Portion of ceramic magnet demagnetization curves are shown in color for comparison of relative flux densities.

Table III—Energies of Ceramic and Alnico Magnets Compared

For ceramic magnet only, external demagnetizing forces must be present to obtain max potential energy

Magnet Materials	Max Energy Product $B_{d1} H_{d1}$, gauss-oerated $\times 10^6$	Max Energy Product Factors		Maximum Potential Energy		Flux Variations and Demagnetizing Force for Max Potential Energy			Easily Utilized Potential Energy, No External Demagnetizing Forces	
						Required Flux Variation, kilogauss		Max demagnetizing force, H_{d2} oersted		
		B_{d1} Kilogauss	H_{d1}, oersted	per unit weight, in.lb/lb	Per unit volume, in.lb/in.^{3}	Min, B_{d2}	Max, B_{k2}		Per unit weight, in.lb/lb	Per unit volume in.lb/in.^{3}
Barium ferrite ceramic	0.95	1.05	900	17.4	2.96	−1.75	1.8	2850	4	0.7
Alnicos										
Cast										
V	5.25	10.2	512	13.7	3.63	10.0	12.1	520	6	1.5
I	1.41	4.7	300	4.95	1.23	3.7	6.1	350	2.5	0.6
II	1.64	4.7	350	6.1	1.56	3.1	6.0	450	3	0.7
III	1.35	4.3	315	4.9	1.21	3.7	6.0	350	2.5	0.6
IV	1.29	3.0	430	5.1	1.30	2.9	4.5	500	2.5	0.6
VI	3.80	7.0	543	11.4	3.05	6.6	9.6	560	5.5	1.5
Sintered										
II	1.45	4.3	340	5.6	1.36	3.4	5.9	400	2.5	0.6
IV	1.20	3.0	400	4.9	1.22	1.8	4.0	530	2.5	0.6
V	3.51	7.8	450	10.5	2.54	6.9	8.8	500	5.0	1.2
VI	2.75	5.5	500	10.4	2.50	4.2	7.2	600	5.0	1.2

Fig. 3—Barium ferrite ceramic magnet demagnetization curve. For normal use such as in holding functions, magnet is operated along portion of major demagnetization curve drawn in color. To utilize maximum potential energy, magnet is operated along minor curve from point k_2 on B axis to intersection of major and minor curves at d_2 in the third quadrant. Operation in the third quadrant is produced when a demagnetizing force stronger than the magnet forces flux through in a direction opposite normal operation. Despite this, magnet flux returns to full value when demagnetizing force is removed.

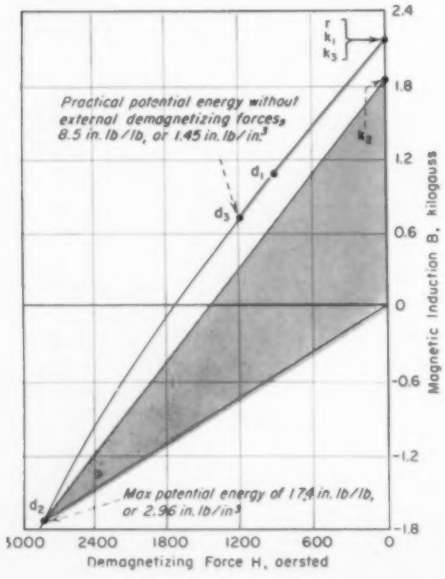


Table IV—Approximate Relative Unit Cost of Unground Magnets in Quantity, for Applications With Small or Moderate Demagnetizing Forces

Magnet Material	Relative Magnet Cost			
	Based on Unit Field Energy		Based on Unit Available Potential Energy	
	Magnet Weight, lb		Magnet Weight, lb	
	1	0.01	1	0.01
Ceramic	0.80	1.25	0.4	0.6
Alnicos				
Cast				
V	1.0	1.0	1.0	1.0
I	2.2	3.2	1.75	2.5
II	2.5	3.0	1.75	2.1
III	2.0	3.25	1.5	2.5
IV	2.5	3.5	1.75	2.5
VI	1.4	1.4	1.25	1.2
Sintered				
II	...	1.5	...	1.1
IV	...	1.9	...	1.3
V	...	1.3	...	1.25
VI	...	1.7	...	1.25

listed in Table III. Data on maximum energy products and easily utilized potential energy are also included. For Alnico V and all other commercial permanent magnet materials except ceramic magnets, maximum potential energy can be readily obtained by designing the magnet (with or without pole pieces) so max demagnetizing force is due to its own demagnetizing field and occurs near the maximum energy-product point on the major curve.

This type operation is obtained in applications in which little or no external demagnetizing force, such as from another permanent magnet or an electromagnet, is present.

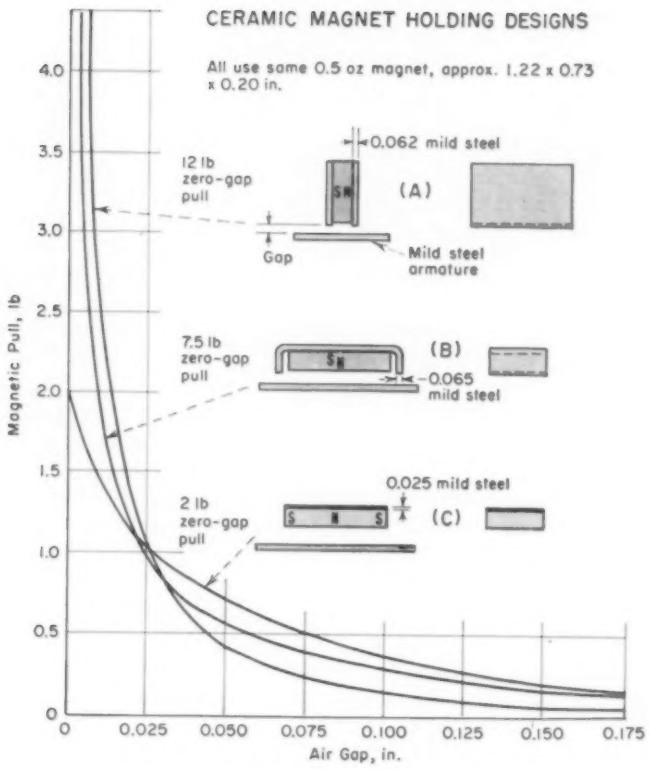


Fig. 4—Ceramic magnet designs for holding applications.

A representative maximum-energy operating cycle for Alnico V is indicated, in Fig. 2, by the operating curve in which the points of maximum energy product d_1 and maximum potential energy d_2 coincide.

Demagnetization curves of ceramic magnet material are shown in Fig. 3. For applications in which substantial external demagnetizing forces are present, ceramic magnets are used because of their high coercive force. This force resists demagnetization to the extent that a stronger opposing field can drive flux through the ceramic magnet in a direction opposite its normal magnetization (Fig. 3), yet upon removal of this external field the flux reverts to the normal direction with no loss in original field strength. This characteristic is obtained because the minor loop coincides closely with the major throughout the upper second quadrant, and maximum potential energy is obtained by operating the magnets down to point d_2 in the third quadrant.

It is difficult to obtain and utilize potential energies close to the theoretical maximum because of losses in pole pieces, difficulty in obtaining magnet operation close to the B_s point on the B axis, and for Alnico, because of variations in operating points along the length caused by flux leakage. Practical values of potential energy which can be readily obtained are approximately one-half theoretical maximum. They are listed in the far right-hand columns of Table III for both ceramic and Alnico magnets; these values should be used only for applications in which no unusual demagnetizing forces are present.

Relative costs per unit energy product or field energy for unground ceramic and Alnico magnets of simple shape are given in Table IV; separate listings appear for magnets of 1 and 0.01 lb. These prices are based on applications in which unusual demagnetizing forces are not present. Sintered magnets cannot be made in 1-lb size and are therefor omitted. Some shapes of small cast magnets can be made more economically by casting large multiple-bar forms and breaking these into small individual segments.

Holding Applications

Ceramic magnets are often used without external demagnetizing forces and in these cases operation is along the major loop. For example, operating flux variations in typical holding arrangements shown in Fig. 4 drive the operating point down close to d_s in Fig. 3. However, the flux is seldom driven below this point unless strong external demagnetizing forces are present.

Variation in magnet pull with change in air gap for three holding arrangements is shown in Fig. 4. The magnet at (A) was magnetized in the direction of pressing; mild steel pole pieces collect and concentrate the flux; they do not extend more than necessary since excessive length increases leakage, forces the magnet to operate higher on the curve, and reduces available potential energy. The (A) magnet is used in (B) but here channel-shaped pole pieces carry the flux from the back to the front. In (C) the same magnet is magnetized with three poles on one side. Added steel plate increases energy available on the front side by providing an easy path for the flux from one pole of the magnet to the other.

Torque Drives

Permanent magnet drives, such as shown in Fig. 5 use circular magnets with a series of poles on the faces. When the magnets are in the attracting position as shown, they will be operating close to point k_s on the zero-H axis of Fig. 3. As torque is transmitted and the magnets rotate with respect to one another, the operating point will move down the curve toward d_2. With a given number of poles, maximum torque produced will be proportional to total potential energy that can be stored in the magnets.

Permanent Magnet Generators

Ceramic magnets are best suited of all commercial magnet materials for applications in which the magnet is subjected to severe demagnetizing forces. An important application of this type is in permanent-magnet generators. In operation, the permanent-magnet rotor induces voltages in the generator windings which produce current flow in the windings and load. However, induced current in the coils produces magnetic flux in a direction opposite that of the permanent magnet flux.

The faster the rotor turns the greater load current flows, and a stronger demagnetizing field is produced. By

Table V—Comparison of Alnico VI and Barium Ferrite Magnets in Generator Service

	Magnets Operated at Max Potential Energy		Ceramic Magnet Operated at Alnico VI Max Potential Energy
	Alnico VI	Ceramic	
Max operating flux density B_{k2} at H = 0, gauss	9,600	1,800	2,100
Flux density B_{d2} at point of max potential energy, gauss	6,600	−1,750	0
$B_{k2} + B_{d2}$	16,200	50	2,100
Demagnetizing force H_{d2} at max potential energy, oersted	560	2,850	1,750
Rotor speed to utilize max potential energy, rpm	325	$5.35 \cdot 10^6$	7,850

evaluating maximum current, (short-circuit current) against the characteristics of the magnet used, it is possible to obtain maximum potential energy by designing the magnet to operate between the points of maximum energy on the major loop d_1 and minimum potential energy k_2 at the $H = O$ axis.

Since the generator output voltage is proportional to the rotor speed, determination of the rpm at which maximum potential rotor energy is developed is important. This speed for a two-pole magnet has been determined to be:

$$\text{Rpm} = \frac{9.4 \cdot 10^8 \, H_d \, L_m \, R}{N^2 \, A_m \, (B_k + B_d)}$$

If this equation is to be applied to a generator of more than 2 poles, or P poles

$$\text{Rpm} = \frac{18.8 \cdot 10^8 \, H_d \, L_m \, R'}{P \; N^2 \, A_m \, (B_k + B_d)}$$

where R′ is the equivalent resistance at the terminals of the coils of 2 poles of the magnet, or

$$R' = 2\,R_c + \frac{2\,R_l \text{ (No. coils in parallel)}}{\text{No. coils in series}}$$

where R_c is the resistance of each coil and R_l is the load resistance.

In using Alnicos for generator rotors, Alnico VI is generally preferred to V because of a greater mechanical strength and higher resistance to demagnetization. In Table V, use of Alnico VI is compared to barium ferrite in the generator of Fig. 6. The rotor magnet is a 1-in. cube of magnet material with two poles. These magnets are assumed to be operated at maximum potential energy in a soft steel yoke containing 1000 turns and connected to a circuit comprising a total resistance of 10 ohms.

If the full potential energy of the ceramic magnet is to be realized it must, Table V, be turned at 5.35×10^6 rpm which is a practical impossibility. However, if the ceramic magnet is operated only to the point of zero B, it will have approximately the same potential energy as an Alnico VI magnet of the same volume at maximum potential energy. Data on a ceramic magnet operated to zero B is given in the right-hand column of Table V.

Alnico magnets are magnetized in place, if possible, since in removing the magnet from the magnetizing fixture to generator yoke the demagnetizing effect of the large effective air gap may substantially reduce residual flux. This lowers the minor operating loop so that under a strong demagnetizing influence the magnet may be operated lower than the point of maximum potential energy on the major curve. Such operation could cause excessive demagnetization. For this same reason it may be important that the stater be constructed so that the poles of the Alnico magnet are always opposite steel sections of the yoke.

For ceramic magnets, these precautions are not necessary, since they can only be permanently demagnetized by a strong external demagnetizing force.

EDITOR'S NOTE—A previous article, "Plastic Bound Magnets", April 1956, page 182, described characteristics and applications of magnets made from ground Alnico and other materials embedded in plastic. While flux density is lower than same solid magnetic material, coercive force is increased. Principal advantage is that magnets can be economically injection or compression molded with high dimensional accuracy.

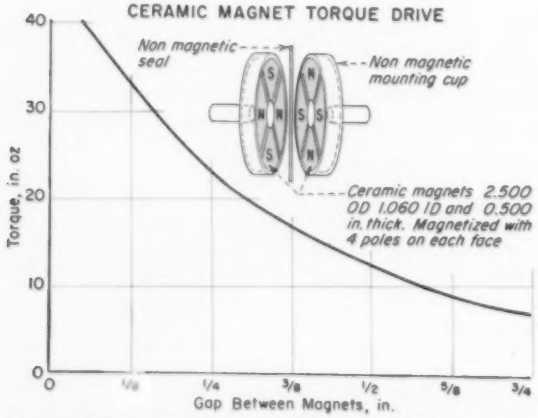


Fig. 5—Variation of torque with air gap for ceramic magnet torque drive.

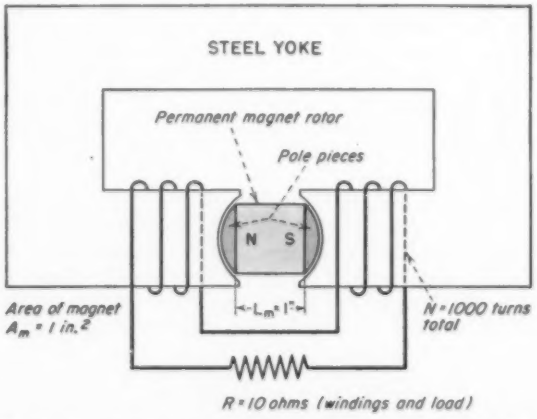


Fig. 6—General diagram of permanent-magnet generator. Magnet used is a 1-in. cube and pole pieces are added.

RESEARCH in the library

The aim of research is to solve problems. It matters little whether the information required is obtained from the literature or from the laboratory. However, it is important to know how to *use* the information derived from either source to best advantage and to consider comparative costs in money, effort and time.

A survey of special libraries in a sample of 100 metallurgical companies has been conducted in order to obtain information about the awareness of management of the contribution that the library can make to the research effort. Preliminary results of this survey are presented.

ALLEN KENT
Associate Director
Center for Documentation and Communication Research
School of Library Science
Western Reserve University

WHETHER ITS PURPOSE IS THE SOLUTION of production problems or the elucidation of nature's laws, research involves the application of knowledge to solve problems. Often the desired solution requires application of knowledge previously acquired, but the basic purpose of research is still the solution of problems rather than the sometimes more glamorous activity of performing experimental work.

No individual contributes more than a small percentage to the vast store of accumulated scientific knowledge. No one mind can encompass any single field of study and few men are authorities even in the highly specialized areas. But in the solution of any particular problem the researcher must saturate his mind with all pertinent information and his source is invariably published literature in the research library.

Effective library organization and integration with the research group is therefore essential and becoming more so every day. The body of recorded knowledge has grown to such an extent that its effective utilization may be a decisive factor in the competitive standing of an organization. Shortage of professionally trained and experienced persons increases the importance of their efficiency in time and effort. Increasing research expenditures and international competition make better storing and finding processes economically and politically vital. This is the province of the research librarian.

How important economically is the effective utilization of recorded knowledge? How can a metals librarian do creative work?

To answer the first question, questionnaires were sent to one hundred companies in the metals field. To date about forty replies have been received with more coming in every day. The questions were directed to the following main areas:

A) Use of information from printed sources.
B) Ways in which information is obtained.
C) Estimate of per cent of research budget involved in maintaining and using library and similar facilities.
D) Estimate of per cent of staff time of various classes of research personnel spent in working with recorded scientific and technical information.

In order to obtain this information with reasonable assurance that the overall company point of view was taken into account, the questionnaires were directed, in general, to the vice president in charge of research and development. In all but three or four cases, the vice president himself completed the questionnaire. The other three or four questionnaires were turned over to the librarians for completion.

A thorough statistical analysis has not yet been carried out since additional replies are still being received. The results presented are to be regarded as indicative rather than conclusive.

Correlation between attention directed toward recorded information and financial success of the various companies, was studied as indicated by their ten year earning record and the percentage increase in net operating profit during the ten year period.

The questionnaire also asked how the recorded information that is required for decision making is gathered (with indication of rank in proportion to extent of use). The alternative possible replies suggested were: asking someone in the organization, hiring outside consultants, personal reading on the part of management, or by direct recourse to company library. Two interesting correlations were observed.

Of those companies that depend primarily on personal reading of management and that depended least on the library 67 per cent were in the last 20 per cent in earning record standing.

Of those companies that depend primarily on the library facility for information for management decisions 67

WHITEHEAD—the philosopher and mathematician pointed out that in order to encourage one's own creative thinking:

"Fear not to be illogical.

Overcome inertia towards change, towards the unconventional.

Realize that insight does not flow from a plan or a logical sequence.

Remove all mental blocks and personal inhibitions; let imagination roam.

It helps to have 'crazy' ideas; these should be encouraged, not ridiculed.

All truly great ideas seem absurd when first proposed."

per cent were in the first 30 per cent in earning record standing.

Another correlation with earning record became evident from answers to a question as to what management expects from the library. Here the alternative possible replies were: a written summary or abstract of information found, the actual articles or books located, or a list of references from which the most relevant are chosen.

Of those companies that expect a written summary or abstract of information found 67 per cent are among the top 45 percent of companies in earning record rank.

The questionnaire requested an estimate of the percentage of scientists and engineers who are believed to be satisfied with present library and similar facilities. Of the companies who have 25 per cent or more scientists dissatisfied with present facilities 80 per cent are in the top 50 per cent companies in earning rank.

Another series of questions was directed to estimating the percentage of working time spent by several classes of employees in studying or searching scientific and technical information.

Of those whose senior scientists, senior technicians, and senior productive men spend more than 6 per cent (up to 15 per cent) of their working time in this pursuit 60 per cent are among the top 50 per cent of companies in earning record rank.

Of those companies whose management personnel spend less than 5 per cent of their working time in this pursuit 67 per cent are among the top 50 per cent companies in earning record rank. (This checks out well with the observed correlation that 67 per cent of those companies that depend primarily on personal reading of management and that depend least on the library are among the lowest 20 per cent in earning record rank.) Evidently managerial time spent in personal exploration of scientific or technical literature is not productive, whereas scientists' time so spent is productive.

Statistical evaluation of the data provided by this questionnaire is not yet complete. However, the results are sufficiently indicative to suggest a number of tentative conclusions.

There is a high positive correlation between the growth in earnings of companies in the metals industry and their degree of dependence on recorded information obtained through their libraries.

There is a high positive correlation between the growth in earnings of companies in the metals industry and the percentage of their research budget devoted to making use of library and similar facilities to identify and to provide information for planning and conducting research and development.

In the overwhelming majority of the metals companies with top earning records, 25 per cent or more of the research scientists are dissatisfied with present informational facilities. This overwhelming positive correlation suggests keen awareness of the importance of proper use of recorded information on the part of management in the top earning companies.

Perhaps it would be premature to draw further conclusions at this time. It seems obvious, however, that the results are sufficiently promising to warrant a more extensive study from which more specifically formulated conclusions might be established.

EDITOR'S NOTE—Allen Kent has had a career as research chemist, scientific editor and documentalist. In his present position, one of his principle activities is in guiding research in the application of high-speed selection devices for searching and correlating scientific information.

He has been author and coauthor of the book "Machine Literature Searching," (Interscience, 1956). He is coeditor of the book "Documentation in Action" (Reinhold, 1956, in press). He is also coeditor of the book "Advances in Documentation and Special Librarianship," Volume I (Interscience, 1957, in preparation). Two other books, now in preparation, are "Semantic Code Dictionary" and a "Textbook on Documentation," (Interscience).

As-Cast Nodular Iron Produced

ACCORDING TO A PAPER BY HARRY K. IHRIG, presented at the 38th Annual Convention of the ASM, Oct. 8-12, 1956, Cleveland, Ohio, cast irons may now be produced with graphite in nodular form in the as-cast condition. The new technique uses calcium silicide (30 per cent calcium). This compound is inexpensive, the reactions upon addition are not dangerous, and no undesirable residues are left in the finished casting.

Typical commercial heats melted in a 36-in. basic-lined cupola furnace have been charged with either straight pig iron, mixtures of pig iron and nodular iron scrap or even straight steel scrap. Approximately 1400 tons of castings have been made, varying from a few pounds in weight to some over 5 tons.

Besides the high strength typical of nodular irons, the ductility has seldom been less than 10 per cent elongation in 2 in. All of the castings made commercially were machined without difficulty, unlike those nodular irons made with metallic magnesium. Any gray iron foundry with basic-lined cupolas or other means of producing low-sulfur iron may be used for the new process. No annealing furnaces are necessary.

A New Nickel-Free Stainless

E. J. WHITTENBERGER
R. H. WITCHEY
R. C. RUDOLPHY
South Works, United States Steel Corp.

In Tenelon—a new austenitic stain less steel—nickel is replaced by manganese and nitrogen to give improved strength and satisfactory formability. Mechanical properties and corrosion resistance in oxidizing, reducing and mildly dilute acids.

TABLE I—CHEMICAL COMPOSITION OF TENELON COMPARED TO OTHER AUSTENITIC STEELS

Grades	Chemical Composition—Weight Percent									
Nominal	C 0.10	Mn 14.50	P 0.050 max	S 0.050 max	Si —	Ni LAP	Cr 17.50	N 0.40	Cu —	Mo —
Production Heats										
Tenelon—I (7 tons)	0.10	15.50	0.030	0.007	0.36	0.24	17.76	0.41	0.09	—
Tenelon—II (40 tons)	0.06	15.20	0.022	0.008	0.52	0.52	18.07	0.51	0.10	—
16Cr–1Ni–17Mn	0.08	17.70	0.030	0.040	0.42	0.75	15.27	0.13	0.08	0.03
AISI 201	0.10	5.60	0.030	0.010	0.49	4.20	17.80	0.15	0.16	—
AISI 301	0.08	1.32	0.028	0.008	0.56	7.43	17.84	—	0.17	0.17
AISI 302	0.07	1.64	0.020	0.006	0.51	8.90	17.69	—	0.14	0.10
AISI 430	0.08	0.35	0.019	0.008	0.25	0.28	16.50	—	0.08	0.03

ALTHOUGH SOME OF THE LOW-NICKEL STAINLESS STEELS, for example ferritic 17 Cr, have adequate corrosion resistance in mildly corrosive service, mechanical properties do not permit extensive drawing and fabrication at room temperature. Austenitic stainless steels such as 18-8 and 17-7, have high percentages of nickel which permit cold working and hot forming operations; however, many of the lower nickel steels contain sufficient delta ferrite at hot working temperatures to present rolling problems. These and nickel procurement problems make the need for fully austenitic nickel-free steel obvious.

The chemical composition of a nickel-free austenitic stainless steel, Tenelon, having hot working and cold forming characteristics similar to the conventional austenitic steels is shown in Table I. This steel has better tensile and yield properties than Type 301, and short time elevated temperature properties exceed those of Typs 201, 304, 347, and 430 stainless steels. Corrosion resistance is similar to Type 430 and 16Cr-1Ni-17Mn.

Tensile Properties

The influence of cold reduction upon the tensile properties of the cold reduced strip product is shown in Fig. 1. The values are typical of the two heats (7 ton and 40 ton) in Table I. Type 301 stainless steel is shown for comparison. In the annealed condition, the nickel-free steel has a greater tensile strength, a yield strength about 2½ times that of Type 301, and an elongation of 40 per cent as compared to 52 per cent for Type 301 steel. These data suggest that the steel in the annealed condition can be used in applications where high tensile and yield strengths are required.

Tensile, yield strength and elongation of the steel may be improved by only 5 per cent cold reduction to equal Type 301 steel in the half-hard condition (about 25 per cent cold reduction). The nickel-free steel conforms to commercial bend test requirements at any gage in the cold reduction cycle. At approximately 35 per cent cold reduction, Tenelon has a yield strength of 185,000 psi with an elognation of 6 per cent. The excellent cold worked properties are a consequence of the high manganese and nitrogen contents.

Elevated Temperature Properties

Short-time tensile properties of the nickel-free steel, Fig. 2, were obtained from standard 0.505 in. dia specimens forged and machined from slab product. The properties are compared with typical values for Types 201,

304, 347 and 430 stainless steels.

Elevated temperature tensile and yield strengths are higher than for any of the comparison steels throughout the entire temperature range investigated. Reduction-in-area values for Tenelon are similar to Types 304 and 347 up to 1000 F; at higher temperatures the values are lower. Elongation values are similar; however, above 1000 F ductility decreases more rapidly than for the comparison steels. The high ductility values for Type 430 at temperatures above 1000 F suggests very rapid softening which cannot be tolerated in even short-time heating applications.

These data indicate that the nickle-free steel exhibits elevated temperature strength superior to Types 201, 304, 347 and 430 steels in short-time tensile tests. The data do not indicate any advantageous use of the steel for prolonged periods at elevated temperatures.

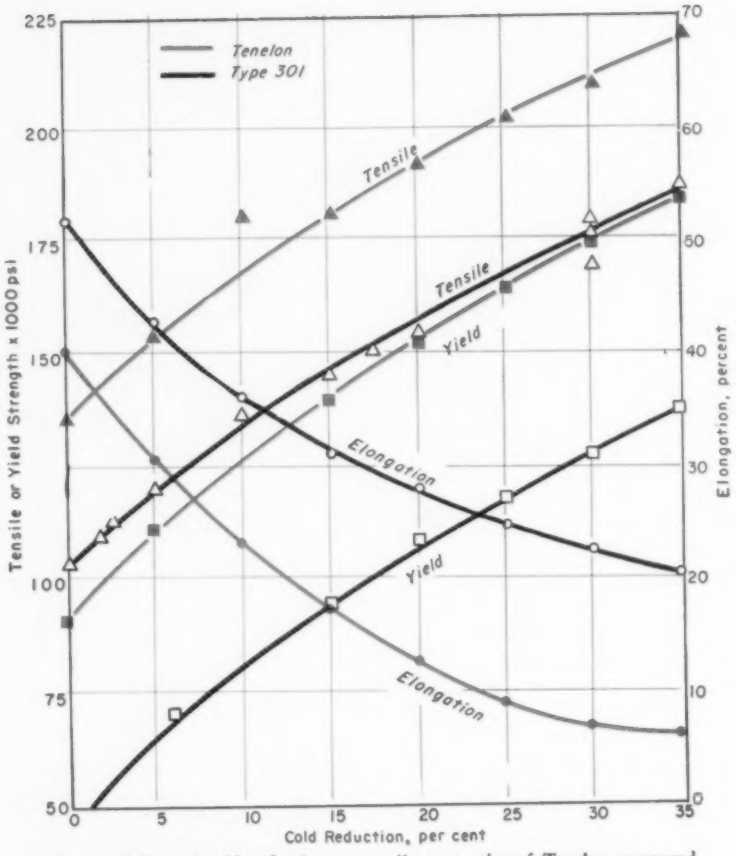


Fig. 1—Effect of cold reduction on tensile properties of Tenelon compared to Type 301 stainless steel.

Corrosion Resistance

Resistance of the nickel-free steels to intergranular corrosion in oxidizing and reducing acids, and to attack by dilute acids are compared to the behavior of a number of currently used austenitic and ferritic stainless steels: Corrosion rates in boiling 65 per cent nitric acid are shown at (A) in Fig. 3; in air-free 5 per cent sulfuric acid at 86 F at (B). In the former medium, Tenelon is more corrosion resistant than 16Cr-1Ni-17Mn and Type 430 but less resistant than Types 301, 302 and 201; in the latter, Tenelon is less resistant than all of the comparison steels. In boiling 5 per cent nitric acid, Tenelon is comparable to 16Cr-1Ni-17Mn steel as shown at (C). Corrosion in dilute acids is less than 0.01 mils penetration per month for both Tenelon and the comparison steels. Dilute acid rate is based on 96 hr exposure in such air-saturated acids as: 10 per cent phosphoric (86 F), 5 per cent lactic (86 F), and 60 per cent acetic (158 F). Multiple sample controlled temperature corrosion cell used for these data appears in Fig. 4.

With nickel continuing in short supply and probably unavailable to many manufacturers in a national emergency, nickel-free austenitics assume increasing importance. Tenelon, with high yield strength in both annealed and cold worked conditions, permits weight reduction in body components on railroad cars and trailer trucks, for example. The material may be deep drawn into such items as cooking utensils and sinks, although the higher yield strength requires increased die pressures. Type 430 stainless, for example, tends to form undesirable surface imperfections or "ridges" during forming.

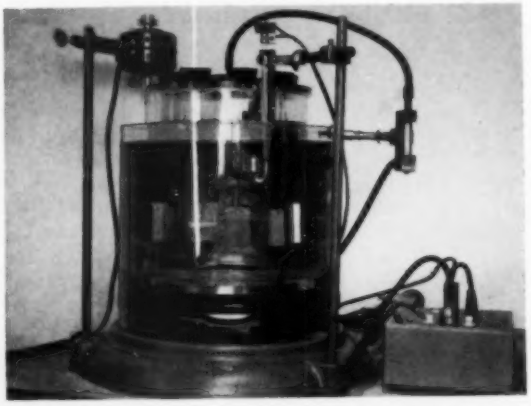


Fig. 4—Multiple sample controlled temperature corrosion cell.

There are many applications where corrosion conditions do not warrant high nickel austenitic steels but where they are used nonetheless. In such mildly corrosive applications as those mentioned previously, Tenelon provides satisfactory corrosion resistance, in addition to improved tensile properties and satisfactory formability.

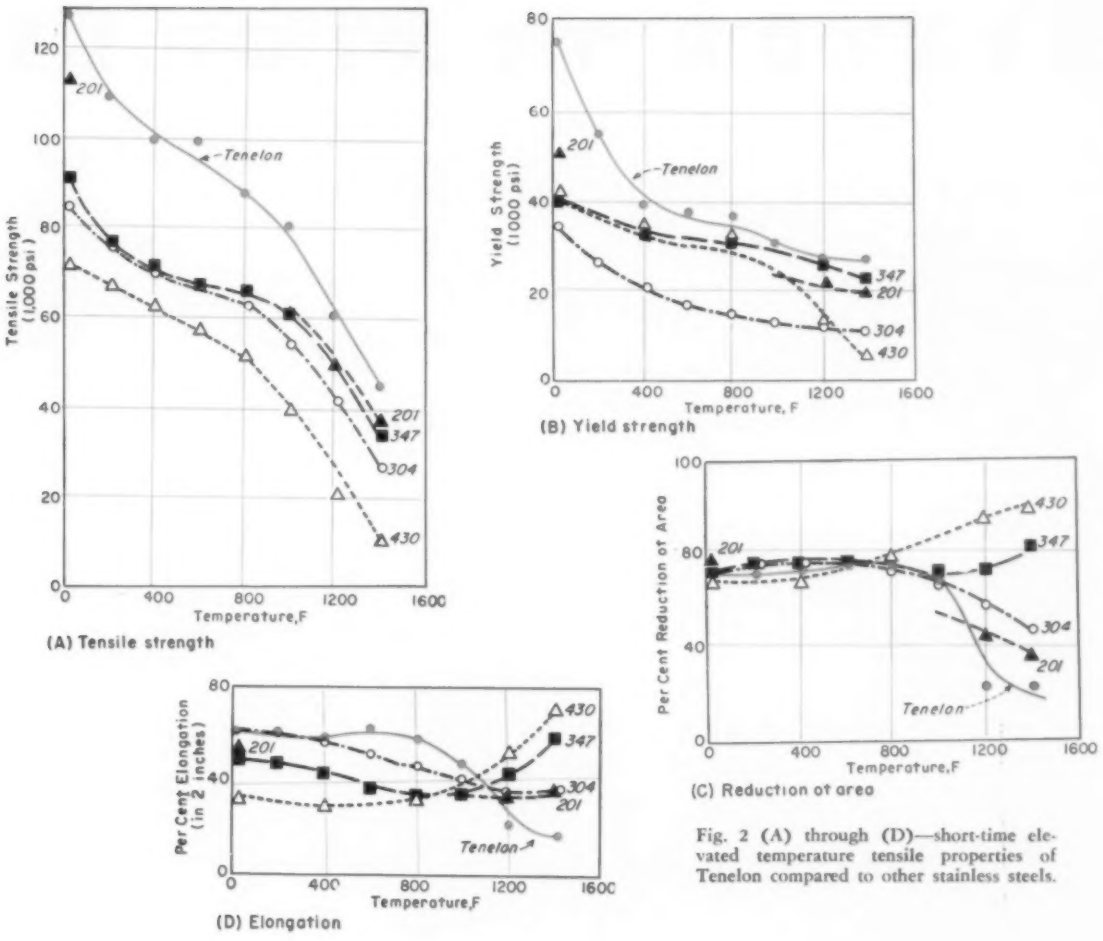


Fig. 2 (A) through (D)—short-time elevated temperature tensile properties of Tenelon compared to other stainless steels.

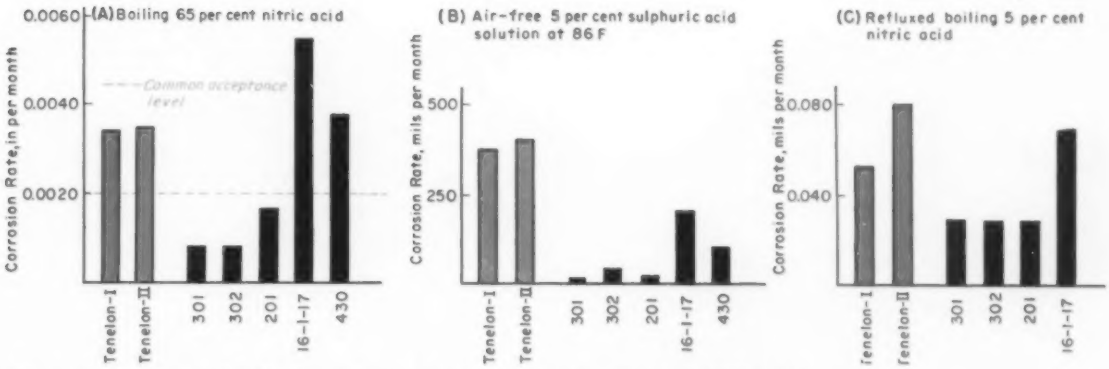


Fig. 3—Corrosion rates for Tenelon and comparison steels in (A) strongly oxidizing acid, (B) reducing acid and (C) mildly oxidizing acid.

EDITOR'S NOTE—Previous articles published in *Product Engineering* on stainless steels include the following:

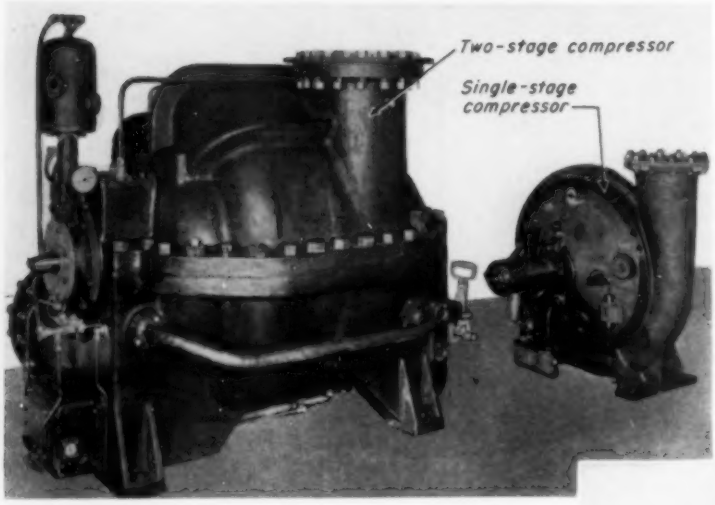
"How to Work Stainless Steel," 1956 Annual Digest, page D9; mechanical and physical properties of 31 standard stainless steel types.

"How to Use and Fabricate Type 430 Stainless Steels," 1954 Annual Digest, page B22; grades available, mechanical and physical properties, comparison with austenitic types, and methods of fabrication and welding.

"Shell Molding of Stainless Steel," September 1953, page 129; factors in design of shell-cast stainless steel parts, and comparison with other casting processes.

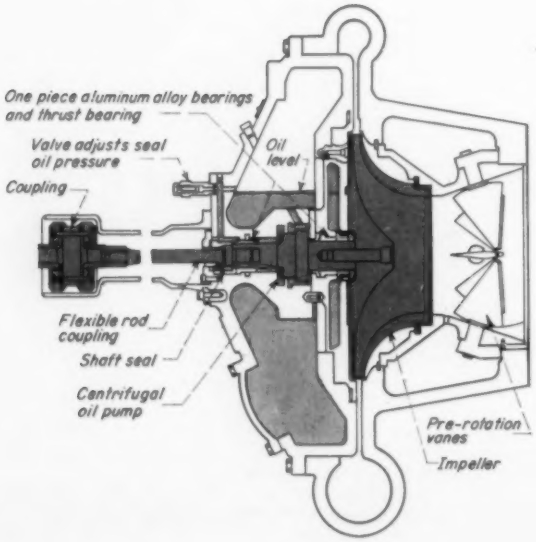
DESIGN FEATURES

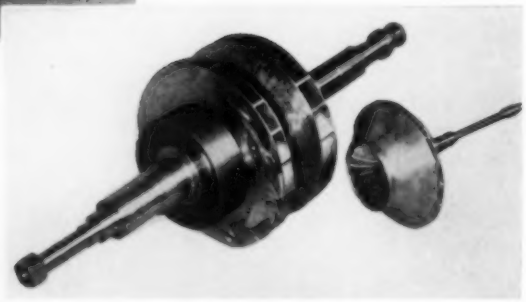
Increasing Compressor Speed Makes Possible Reduction in Size and Weight



◀

SINGLE-STAGE COMPRESSOR uses "freon 114," runs at 10,000 rpm, and handles refrigeration loads up to 550 tons. It has 300 parts and weighs 1600 lbs. Two-stage compressor used "freon 11," ran at 7000 rpm, had 1100 parts, and weighed 7600 lbs; it handled loads up to 400 tons. Reduced size results from using high-speed single-stage rotor which has a shorter span between bearings. Making impeller a one-piece aluminum casting in place of an assembly of stainless steel forgings helps reduce rotor weight from 390 to 27 lb.



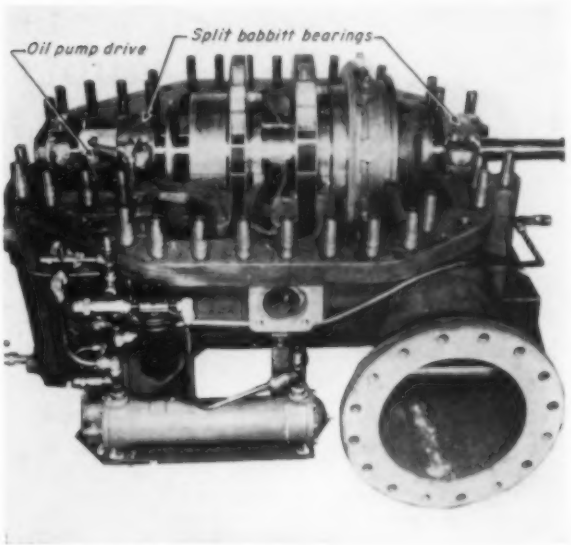


◀

OIL LEVEL IS HELD ABOVE BEARINGS to flood them for starting. Pressure is developed by radial drilled passages in a boss on the rotor shaft, making a gear driven pump unnecessary. Rotor assembly is only moving part in compressor. Only external oil piping is that required to carry oil to cooler and filter. In old unit, shaft seals admitted too many dirt particles and made a fine filter impractical. This caused wear in bearings where clearances were around 0.0005 in. In new design, little or no leakage occurs and particles are fine, so a micronic filter is used. As it takes out all particles over 10 microns, bearing wear is practically nonexistent.

IN NEW PRODUCTS

Running at higher speed, a single-stage compressor handles greater refrigeration loads than its two-stage predecessor. Designed under the direction of J. H. Anderson at the York Corp., York, Pa., the new unit is smaller, lighter, has fewer parts, and costs less to build.



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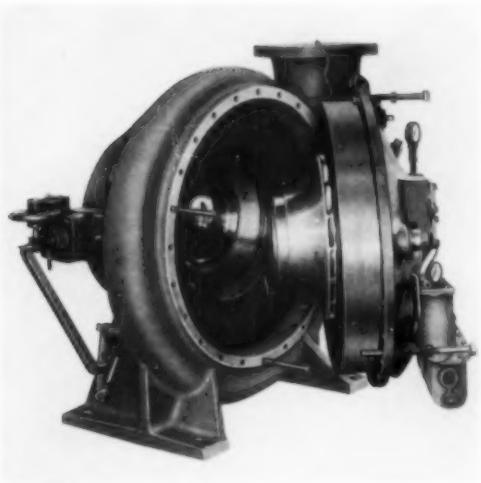
TWO-STAGE UNIT had forced feed lubrication system, with a gear driven pump which drew oil from a sump in the casing. An external pump fed oil to the bearings for starting; oil level was below bearings because casing was split on horizontal center line. Shaft diameter was large to obtain stiffness required to support heavy impellers and gear type coupling between compressor and speed increaser. This produced high rubbing speeds at the shaft seal and made it a major cause of maintenance. Complicated passages in casing made an irregular horizontal joint which was difficult to seal.



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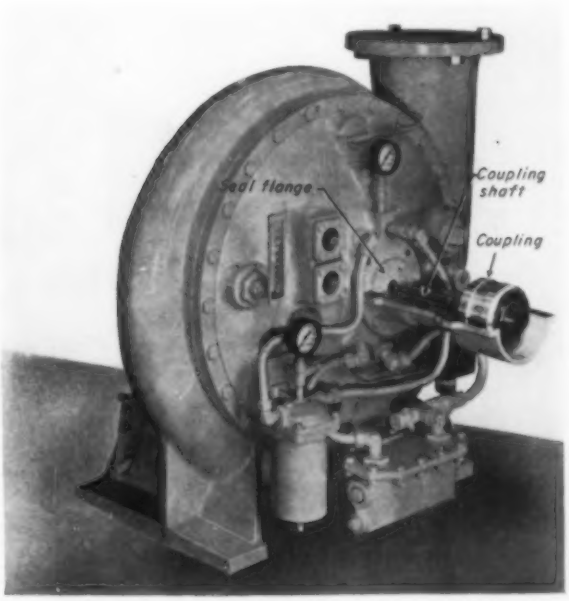
ALL RUNNING PARTS are in rotor support which is removed for repair by opening the vertical flanged joint and substituting a new package; down-time is about a half day. This casing joint is easier to seal, and reduces possibility of water vapor and air leaking into system. Oil heaters are ¼ the wattage of those used in two-stage compressor, because oil volume is much less, and do not need thermostatic control. In old unit, heaters were installed directly in the oil and could not be replaced while compressor is running. In new unit, heaters are in metal wells.

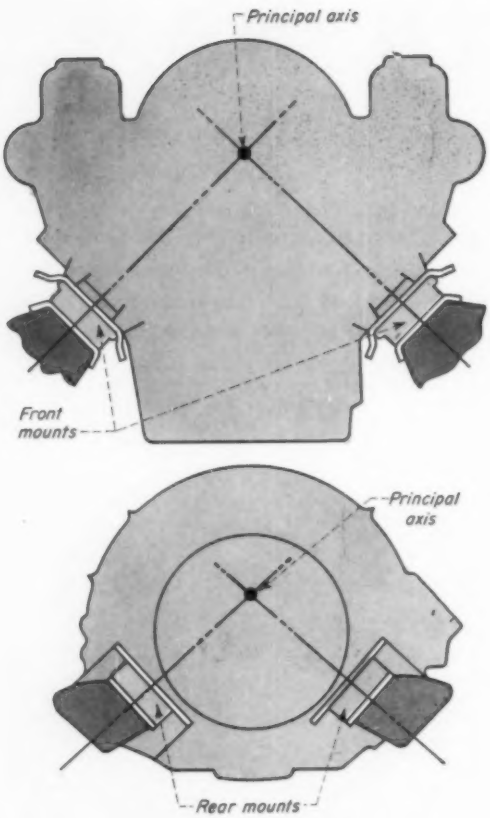


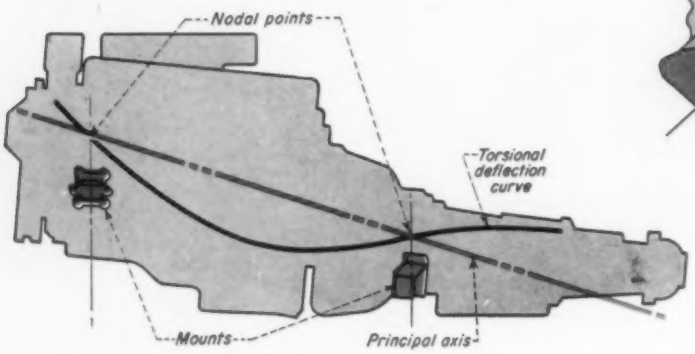
▶

LIGHTWEIGHT FLEXIBLE COUPLING used on single stage unit screws on shafts and is not supported by rotor. Coupling shaft is only large enough to transmit torque, making possible a small diameter shaft seal. Rubbing speed is lower although rotor rpm is higher, and leakage area is much smaller than in two-stage unit. Seal is in a small compartment, sealed from the gas by oil, and is inspected or replaced without opening the compressor by removing the coupling and a small flange.

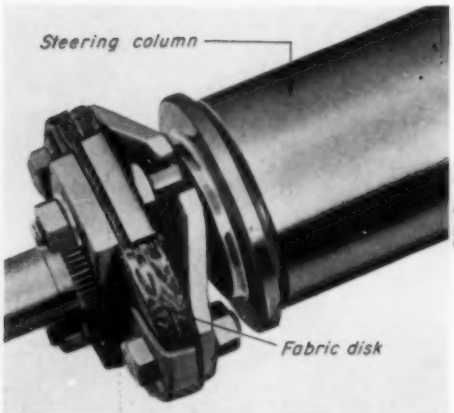
Nodal Point Engine Mounts Isolate Vibrations

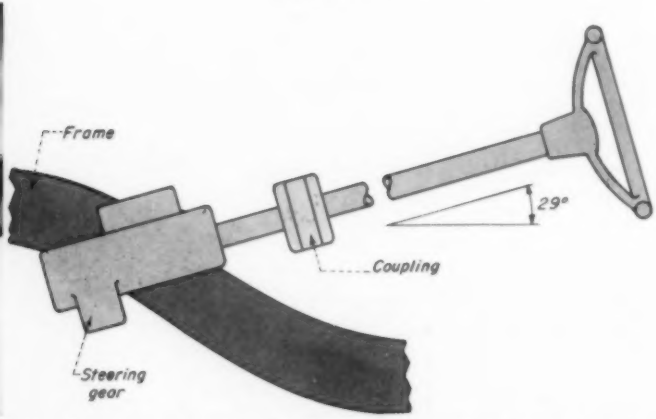
Engine mounts of the 1957 Buick are at nodal points of the torsional deflection curve to reduce vibrations transmitted to the frame. Lateral stability is increased by placing mounts so engine weight preloads them in compression, while reaction torques are resisted in shear. Also, a flexible coupling is used in the steering shaft with the steering gear mounted rigidly in the frame.





MOUNTS ARE PLACED so a line through their center perpendicular to the surface passes through the engine's principle axis. They resist reaction torques only by deflection in sheer. As their shear rate is about 1/9 the compression rate, a "soft" engine "feel" results. Lateral stability, obtained from their angular position, increases lateral control of the transmission torque ball and reduces rear wheel kick.

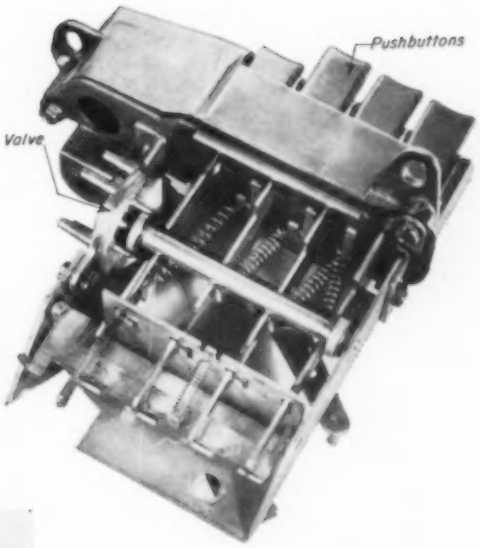


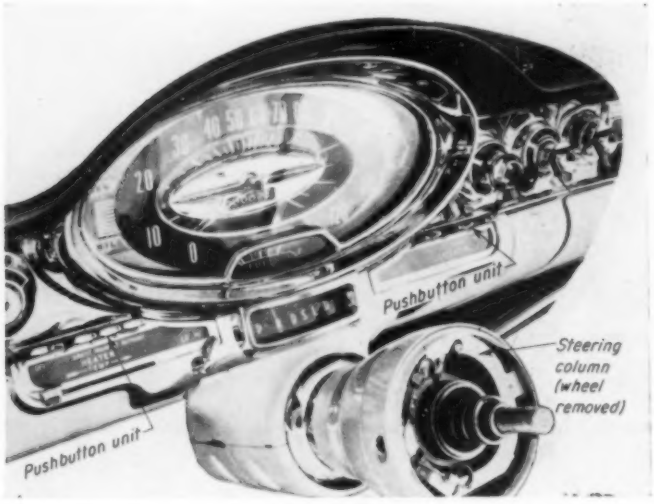


FLEXIBLE COUPLING in steering shaft allows motion for alignment with the column, although steering gear is mounted rigidly in frame. Previously, steering gear was suspended on trunions so it could pivot. New design keeps desired angle at steering wheel although car is lowered by changes in the frame. Same coupling is used for both manual and power steering.

Push Buttons Control Vacuum-Operated Dampers

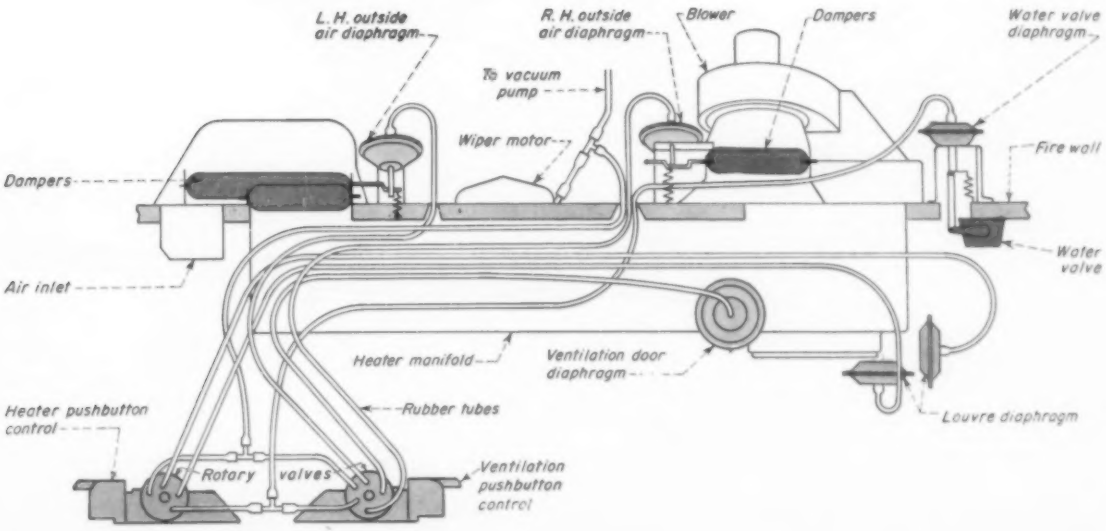
Vacuum operated diaphragm motors position dampers in the heating, ventilating, and air conditioning systems of the 1957 Oldsmobile. Damper positions are selected with push buttons which index valves to connect diaphragms to vacuum or vent them to atmosphere.





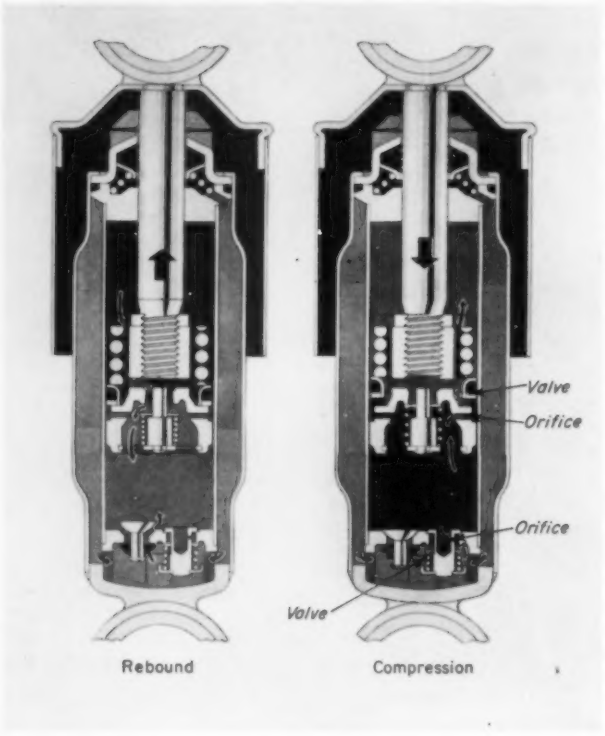
PUSH BUTTON UNIT is similar to those used for tuning radios except that selector valve replaces the tuning condenser. Valve is made of 2 die castings, spring-loaded together. Fixed casting mounts tubing and a felt pad which filters air drawn into the system. Labyrinth passages in the rotating casting change port connections to program the dampers for which ever button is pushed.

Heater capacity has been increased 12 per cent by using larger core and water lines; air flow to the heater has also been increased. Vacuum system allows grouping of controls at an accessible spot on each side of the steering column; controls are illuminated for easy operation at night.



Air Cushion Supports Rear Springs

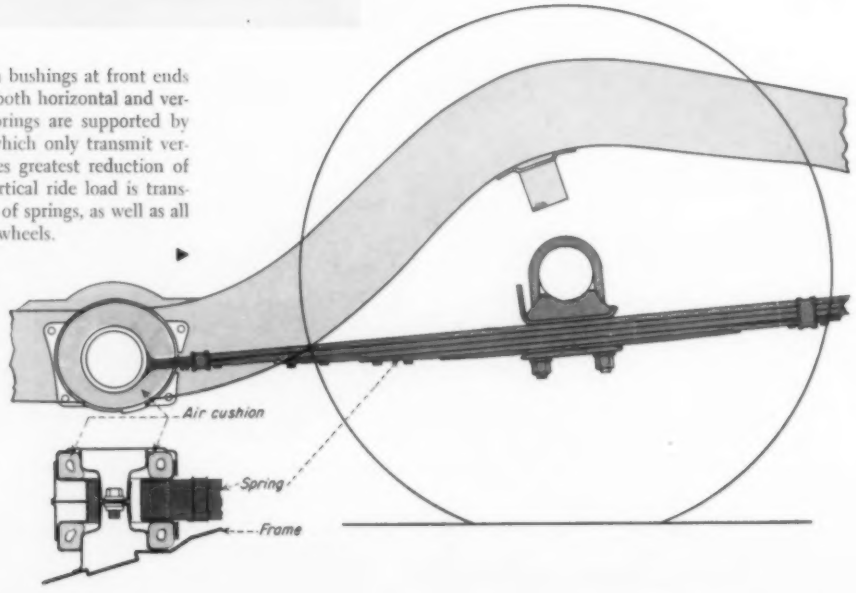
To cushion road shocks at the rear wheels, Mercury mounts the front end of each rear spring in 2 rubber doughnuts filled with air. Also, shock absorbers have variable resistance for control at all displacement velocities.



◀ **ORIFICES** in old shock absorber produced too much resistance to oil flow at low speeds, and limited cushioning effect for impact loads at high speeds because of compromise in blow-off setting. New design allows reduction of resistance for small magnitude impacts on boulevard rides and allows restrictions to take over control for greater impacts at high speeds or on rough roads.

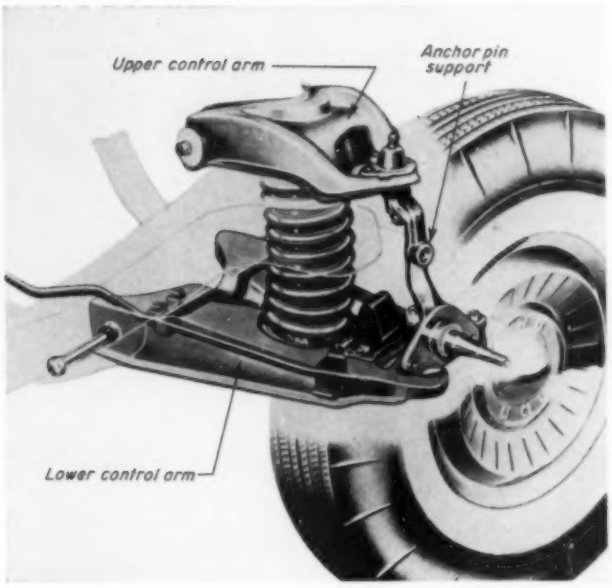
AIR CUSHIONS are held in bushings at front ends of rear springs, and transmit both horizontal and vertical forces. Rear ends of springs are supported by links pivoted in the frame, which only transmit vertical forces. This design gives greatest reduction of shock loads as about ¾ of vertical ride load is transferred to frame by front ends of springs, as well as all longitudinal road shocks on wheels.

▶

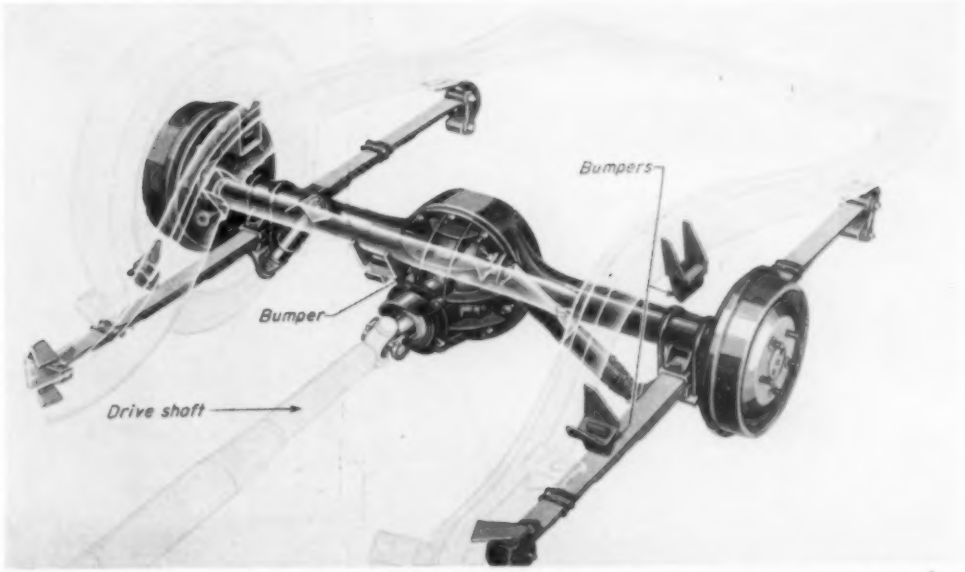


Wheel Suspension Has Fewer Parts, Less Weight

Simplified front suspension construction of the 1957 Ford results in fewer parts, less weight, easier servicing, and lower manufacturing cost. In addition, the offset between drive shaft and rear axle has been increased to help lower the car floor, and a variable-rate rear suspension has widely spaced springs which cradle the lowered frame.



FRONT SUSPENSION lower arm has ¼ as many parts as last year's design. Machine assembled ball joints with stamped sockets replace bench assembled units with forged sockets, and control arms are one-piece stampings instead of assemblies of smaller stampings. New design increases rigidity, with a 10 per cent weight reduction. Steering arm, spindle, and spindle support are one forging which also supports the front brake anchor pin. This maintains shoe alignment and reduces unsprung weight as brake shield, which carries little load, can be lighter material.

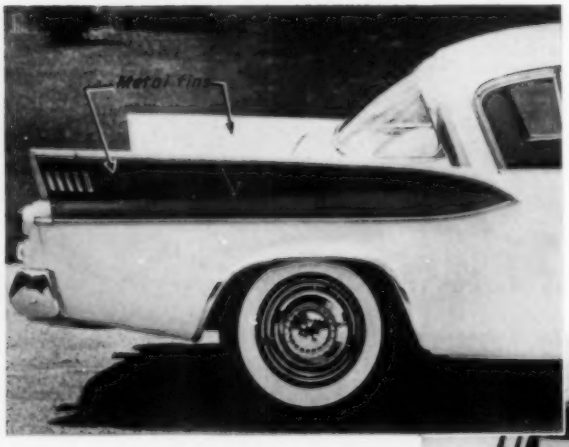


DRIVESHAFT is offset 2¼ in. below the rear axle, and its rear section tapers from 3¼ in. to 2 in. This allows lower body styling without increasing the tunnel height. Rubber bumpers halfway between axle and front support of spring make a variable-rate rear suspension. Rear springs are longer, with 4 leaves instead of 5. A bumper on the frame cross-member, which contacts a pinion carrier shield, gives progressive absorption of strike-through from hard bumps. It strikes first, and twists the axle housing and spring before the housing finally bottoms against bumpers on the frame. Lateral stability is increased by mounting the springs on outside hangers.

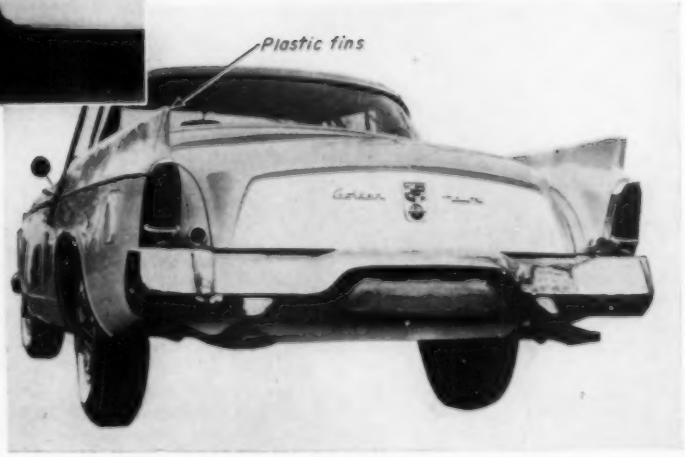
Reinforced Plastic Makes Rigid Truck Grill

Glass reinforced plastic is used for the grill of the 1957 Studebaker trucks, while it has been replaced by steel in the fins of the "Golden Hawk" sports car. Experience indicates that this material is best used for complex shapes produced in small quantities. Open grill design increases area for flow of engine cooling air.

▲ **FIBERGLASS REINFORCED POLYESTER PLASTIC** is used for truck grills where production rate is relatively low and low tooling cost necessary. Grill is molded in one piece, and has high resistance to impact and abrasion. Finished in a different color than the hood and fenders, its texture is an asset. Absence of large flat areas avoids surface undulation problem.

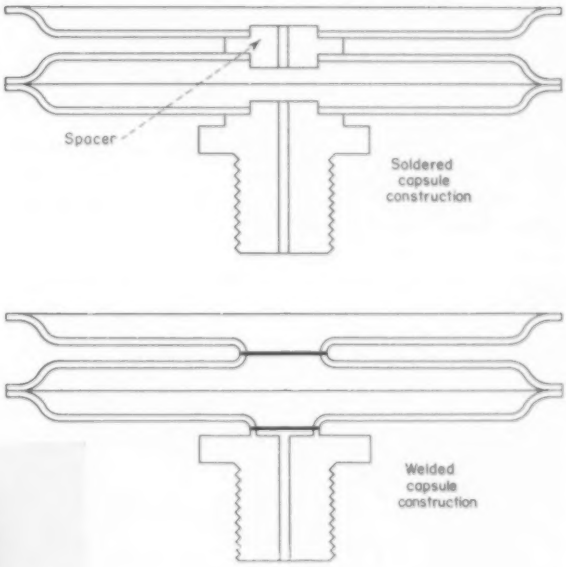


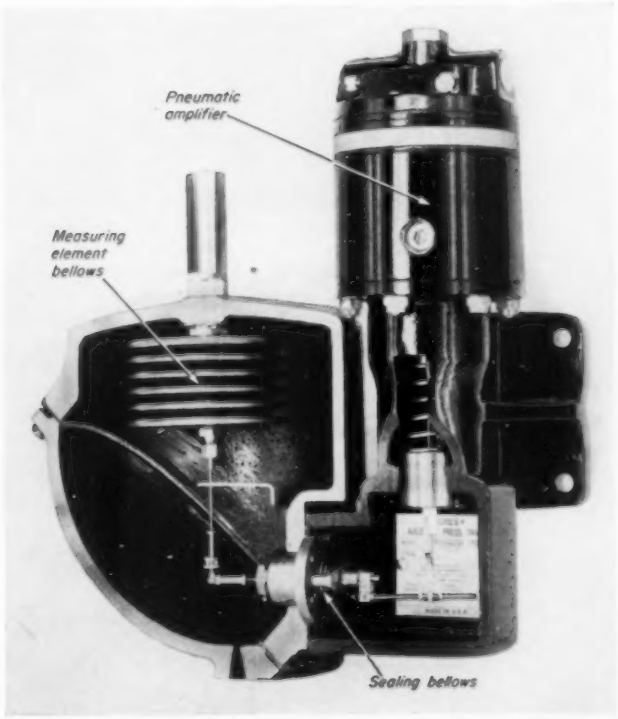
STEEL has replaced reinforced plastic, however, in the fins of the 1957 "Golden Hawk" to simplify assembly operations. Plastic fins were economical in lower quantities, but dimensional instability made it necessary to drill matching mounting holes in fenders at assembly. Also, texture and undulations in flat surfaces were not compatible with finish of adjacent metal surfaces of the same color.



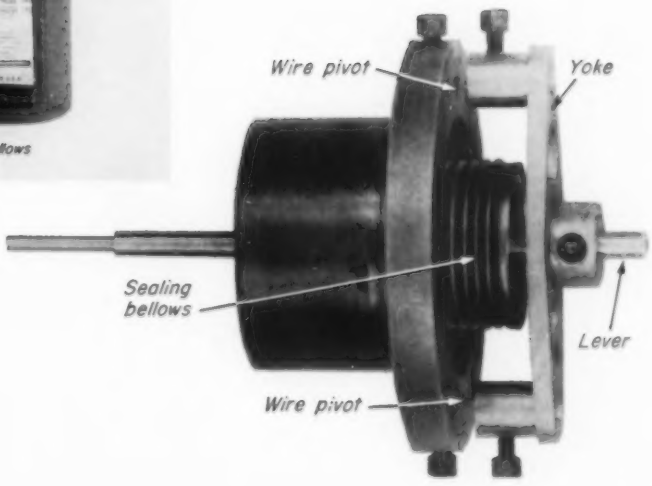
Bellows Is Redesigned for Welding

To prevent process contamination by corrosion products, stainless steel capsular elements are used in an absolute pressure transmitter made by the Bristol Co., Waterbury, Conn., instead of capsules of phosphor bronze. This required redesigning the capsule for inert gas arc welding, as bronze units are soldered.





SPECIFICATIONS called for 316 stainless steel in all parts contacting the process fluid and ruled out bronze capsules, as the process reaction would be reversed by contact with copper bearing materials. Bronze capsules are soldered and joined with brass spacers to form an element. Temperatures used to weld stainless steel required thin sections at all joints, so washers were abandoned, and fitting was machined to size at the welded joint.



MEASURING ELEMENT transmits pressure signals to pneumatic relay by motion of lever pivoted at seal in bellows housing; lever is supported on flattened wire hinges which flex for small vertical motions but are rigid in the horizontal plane, and passes through the stainless steel bellows which forms a flexible seal. Change to stainless steel required thinner sections in measuring and sealing bellows to get sensitivity required for service in range of 0 to 5 mm hg abs. The transmitter produces 3 to 15 psi signals for remote indication, recording and control.

Reshaped Housing Improves Calculator's Appearance

Operator's criticisms, as well as engineer's suggestions, helped develop the new Facit automatic calculator. Swedish industrial designers Sigvard Bernadotte and Acton Bjorn guided the exterior design to evolve a simple, unified form which is easily produced. Although it uses basic mechanism of previous design, the new machine is easier to read and is operated with less fatigue.

NEW HOUSING is an aluminum die casting with same green wrinkle finish as the welded steel housing of previous design. This color was carried over to the new machine, as a recognized identification of the Facit line, to reduce the impression of change on customer acceptance. Simple shape with integral keyboard guard attains unity of form and avoids appearance of an assembly of shapes, characteristic of the old design. Lighter shade of green and smooth texture of counter face plate makes machine seem smaller and lighter. "Facit", placed across back of housing, introduces a horizontal line for effect of less height, and displays maker's name where customer's visitors will see it.

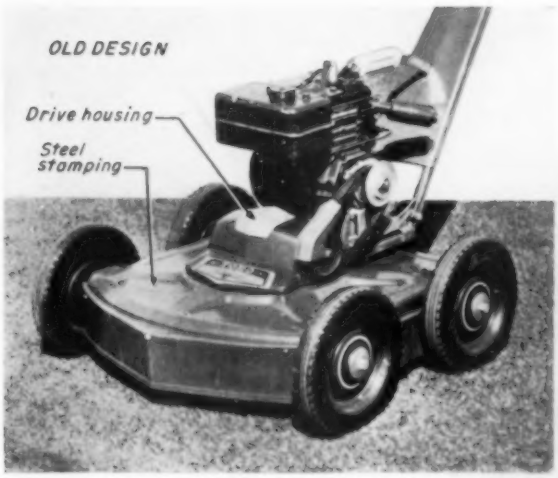
▲ NEW DESIGN

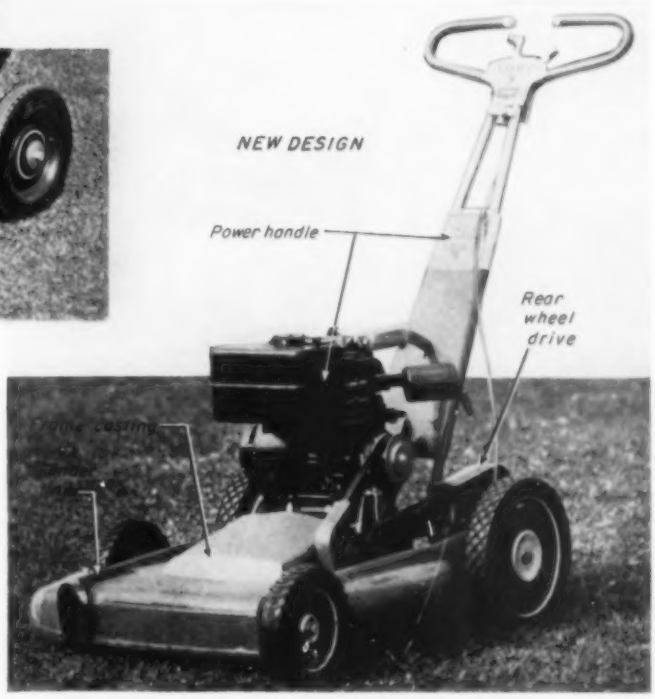
COUNTERS ARE EASIER TO READ as mechanism has been tilted forward to place them closer to windows in housing. This was done by raising the rear shock mounts. Shelves in front of counter windows are now below line of sight, do not obstruct view, and, because of texture and color, reflect more light on the counters. Tilted mechanism also puts keyboard at a more comfortable angle for the operator. All controls are grouped with keys at front of machine and inside keyboard guard which is now integral with housing. On old design, operation selector lever projected below and beyond the guard, and the positive-negative selector mechanism was at the side. Keys have been reshaped to avoid hurting operator's fingers after prolonged operation. Keeping all levers inside the guard makes unit less liable to damage from shipping and handling, an important consideration in a product designed for an export market.

▼ OLD DESIGN

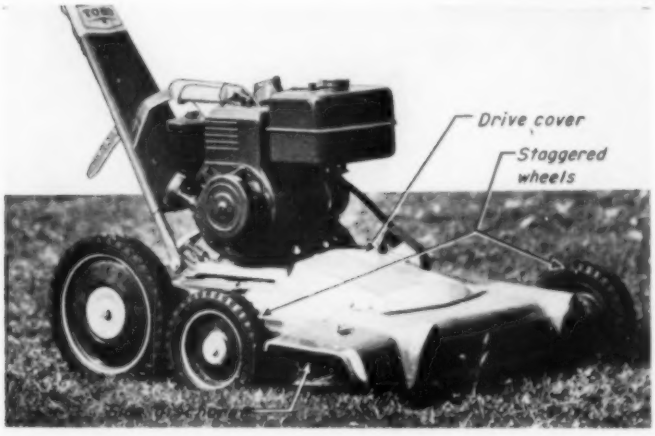
Restyling Gives Mower Product Identity

Styling a rotary mower with automotive lines gives it individuality, and makes it appear longer, although constructed around the basic circle of the cutting blade. Improvements do not stop with eye-appeal; the new rotary cuts a wider swath, is better suited to uneven ground, and makes less noise. It is the result of cooperation between engineers at Toro Manufacturing Co. and industrial designers of Charles Butler Associates. This Unit is one of ten used with Toro's basic Power Handle drive.





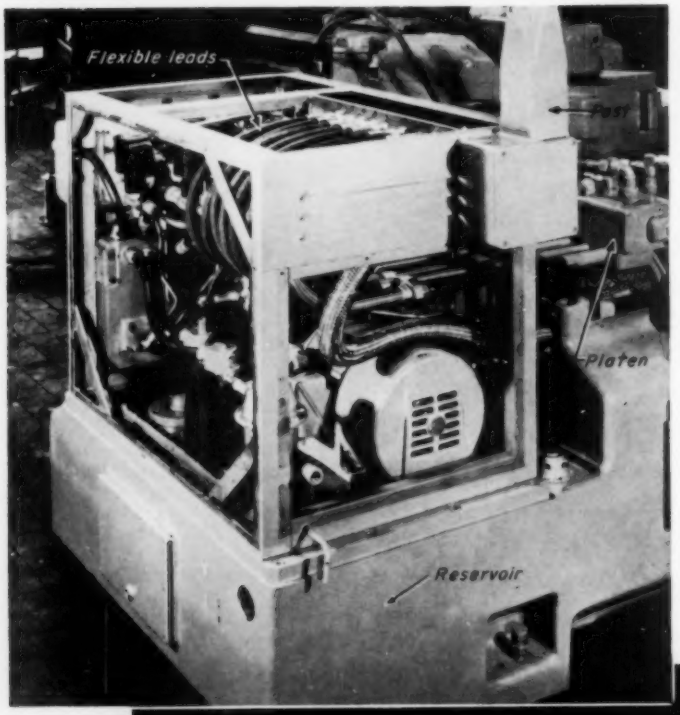
MAIN FRAME OF NEW DESIGN is an aluminum casting. It is lighter and more rigid than old frame, damps noise-making vibrations, and costs less. Previous design used heavy steel stamping with a separate casting to support drive mechanism, and had high tooling cost. It amplified noise from engine vibrations and accentuated the basic square which enclosed cutting blade and axles. Functional fore and aft ribs make casting rigid and add the long fender lines which create appearance of greater length and establish the product's individuality.



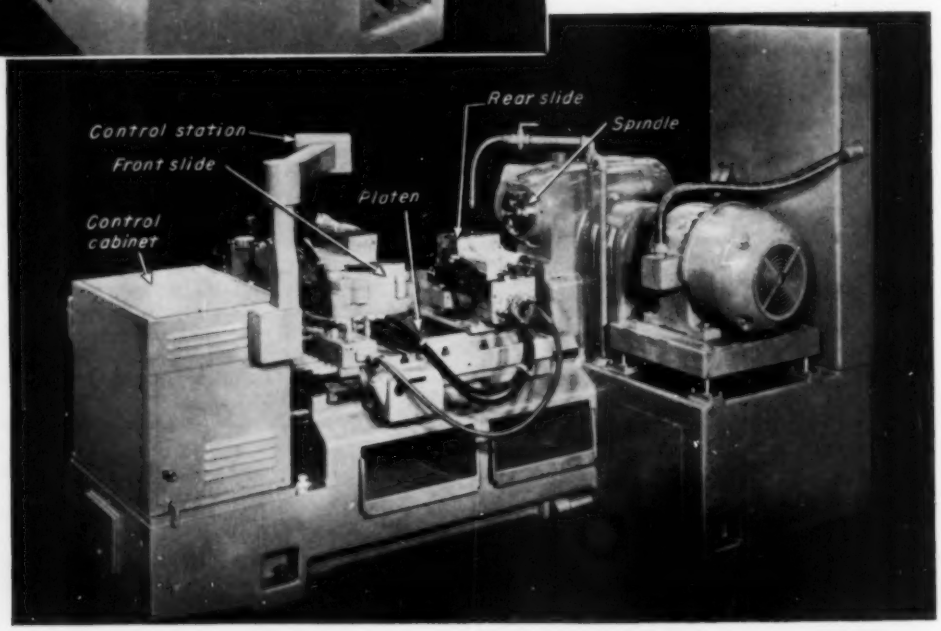
STAGGERED FRONT WHEELS facilitate side discharge of cuttings and, by supporting machine's center, prevent "scalping" of soil when used on uneven ground. Side discharge reduces engine load by decreasing distance cuttings are carried; old design discharged at rear. New drive is on rear wheels, under the center of gravity, and has fewer parts; old unit used chain drive on front wheels. Cast drive housing of old design is replaced by a sheet metal cover blended into integral end housing and bearing block. Designers and engineers developed a full size clay model over basic mechanical elements so product designers and sales management could settle questions of style, operating features, and production cost before making working prototypes.

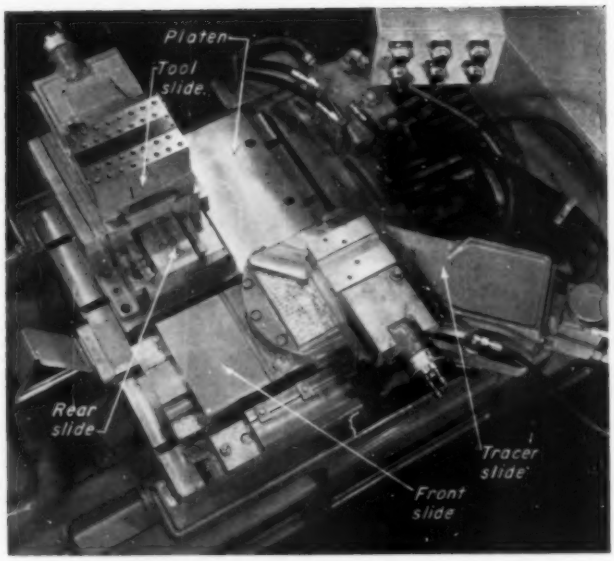
Unitized Control System Cycles Tracing Lathe

Electric and hydraulic controls for the tool slides of a chucking lathe are grouped in a cabinet to simplify wiring and piping. An electro-hydraulic automatic-cycling system, and a pneumatic-hydraulic servo which positions a tool slide from a template are in this machine made by Monarch Machine Tool Co., Sidney, Ohio.

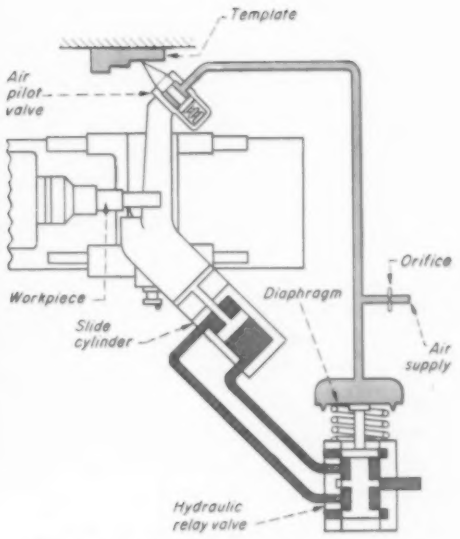


GROUPING SOLENOID VALVES across top of cabinet simplifies wiring to electric controls and piping to hydraulic pump. Flexible lines connect the valves to rigid extension pipes which carry oil lines for all slides into rear of platen. Control cabinet is mounted over the reservoir for hydraulic fluid and the motor driven oil pump. Electric controls for cycling tool slides are on an arm which swivels on post at corner of cabinet. Slide feed rates are set with controls on front of cabinet.

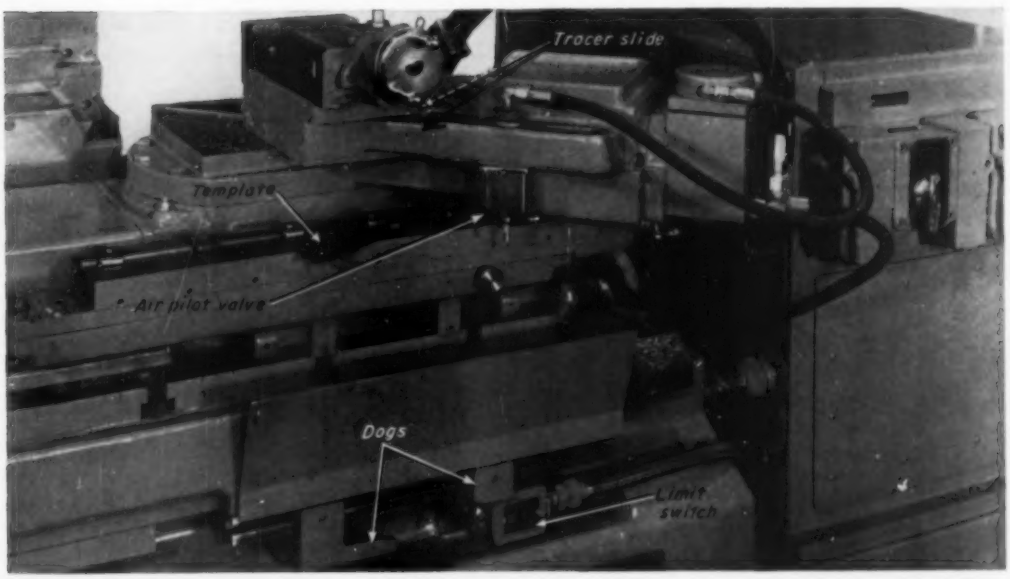




Front and rear slides are on a platen which moves them up to the work as automatic cycle starts, and withdraws them when it is completed; platen is positioned on ways parallel to lathe bed. Hydraulic cylinders also position and feed the front and rear tool slides. Front slide feeds parallel to platen while adjustable rear slide is shown arranged to feed across the lathe. Rear slide carries a second slide to provide tool relief when withdrawing from the work; front slide carries the air-tracer unit.



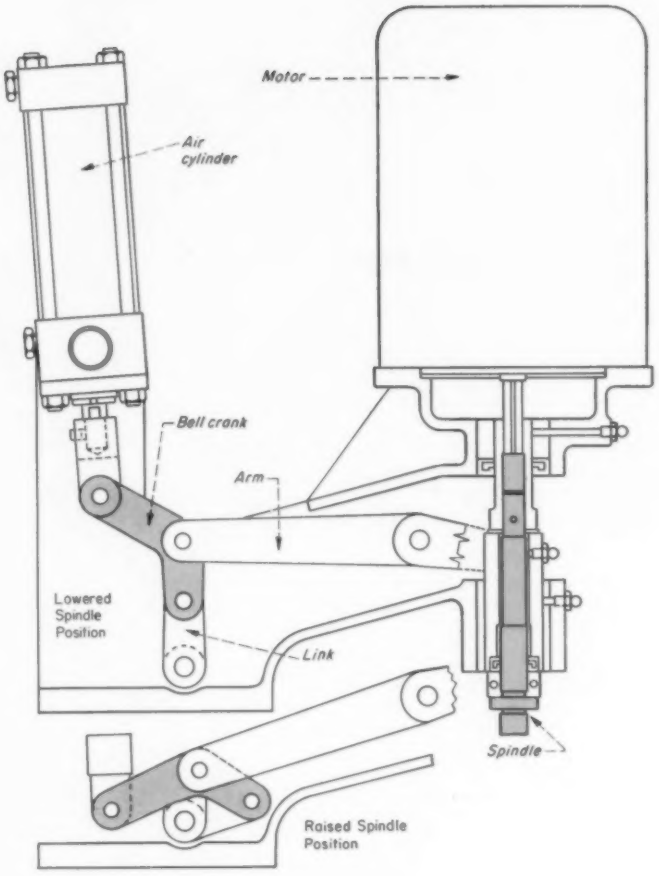
AIR BLED FROM THE PILOT VALVE varies with stylus position, and controls pressure in diaphragm motor which positions the spool of the hydraulic relay valve. As front slide feeds, template deflects stylus and repositions tracer slide until stylus and relay valve return to neutral position. Air flow is restricted by orifice in supply line so pressure in diaphragm chamber is determined by resistance at air pilot valve.



TRACER SLIDE moves diagonally across front slide, and carries the air pilot valve which rides against template on platen. It also carries the diaphragm operated hydraulic relay valve. Dogs and limit switch below platen are typical of units which sequence all slide movements during automatic cycle.

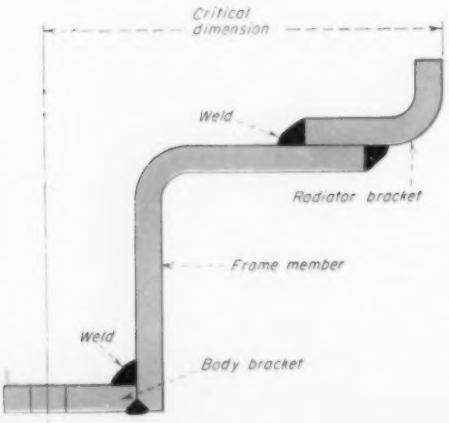
Toggle Links Change Linear Motion to Rotation

An air cylinder drives a rotating arm to lower the spindle of a spinning riveter made by High Speed Hammer Co., Rochester, N. Y. Piston rod and arm are connected by a toggle linkage which accelerates the spindle to start the downward motion, and provides a positive limit and dwell at the lowered position.



PISTON ROD moves upward to rotate arm and lower spindle, and is connected to the arm by a bell-crank. Arm is connected to the crank center, and a link, pivoted in frame, connects to the other end to form a toggle. As piston rod rises, crank and link rotate so arm pivot describes arc while piston rod pivot moves in straight line. Linkage arrangement produces large forces to accelerate spindle at start of stroke and aligns lower link and crank arm in vertical position to provide a positive lower limit.

Lapped Joint Compensates for Tolerances in Welded Frame



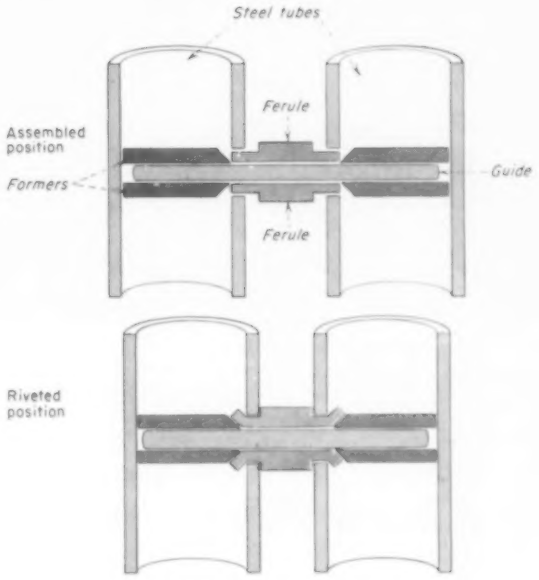
Critical dimensions are held by designing welded assemblies so lap joints are adjustable to compensate for tolerance build-up. Method is used to assemble frames for fork lift trucks by Towmotor Corp., Cleveland, Ohio.

FRAME SECTIONS are electric-arc welded in hydraulically operated jig. Before using lap welds, welder had to vary weld thickness at butt joints to hold critical dimensions. This left a gap for the weld to bridge or required removal of material to fit parts, making a more costly joint. Lap joints at selected points in assembly make it possible to set critical dimensions before making final weld.

Hidden Rivet Joins Tubular Parts

Steel tubes for corner legs of tables made by Norman & Co. Ltd., St. Peters, South Australia, are joined with a special rivet which requires drilling each tube on one side only. This method proved better than bolting or welding.

LEGS ARE SEPARATELY CHROME PLATED and were first joined with studs and dome nuts which made a protrusion at ankle height. Welding legs together was unsatisfactory as this had to be done before plating, and then a suitable chrome finish could not be obtained in the "shadow" between the legs. With special rivet, legs are drilled on one side and assembled over the rivet unit. Pressure applied to outside of legs pushes them together and forces rivet ferrules up over forming elements. Method proved cheaper and faster, and made a better appearing product.



Variable speed roller chain drives operate spindles of a high speed boring mill made by rebuilding an old turret lathe. This required a special chain tightener to hold correct tension on the chains.

Pre-punched cards program a detailed rolling schedule for a reversing roughing mill. Card data is read and stored in a transistor memory element which controls the mill through magnetic amplifier output units.

A rubber compression member inside the ram, and a spiral lifting spindle are used in a chain-lift drop forging hammer to obtain high stroking speeds and infinitely variable stroke selection.

Fire retarding chemicals are linked into the chemical structure of a fiberglass reinforced plastic lifeboat during manufacture. The boat is molded in one piece with built-in buoyancy.

Vertical corrugations in stainless steel wall panels made by Budd Co. for a Fruehauf trailer increase useful volume by making upright wall supports unnecessary.

Traversing the headstock and keeping the worktable stationary reduces by 200 sq. ft. the floor space required for a dual-spindle horizontal boring machine made by National Gas & Oil Engine Co. Ltd. of England.

Sandwich structures of reinforced plastic and rigid insulation are formed into a one-piece truck body in a single molding operation. Body, which is used on a refrigerated truck, is made by the Heil Co., Milwaukee, Wis.

Sealed bearings are used throughout a fork-lift truck made by Lewis-Shepard Products Inc., Watertown, Mass.

A single piston stroke forms both filling and shell for candies in a machine made by A. Savy, Jeanjean, Courbevoie, France.

A magnetic amplifier designed by Ryan Aeronautical Co., San Diego, California, is 20 times as reliable, but only ⅓ the size and weight of the vacuum tube amplifier it replaces.

Spiral tube bundles in heat exchangers made by the Graham Manufacturing Co. compensate for thermal expansion, and increase fluid turbulance to provide higher heat transfer capacity.

Hydraulically floated die tables have replace spring supported tables, in the new metal powder presses made by Bussmann-Simetag of West Germany, to provide adjustable resistance to die motion.

Neoprene hose used in place of copper tubing has stopped fatigue failures in fuel lines of outboard motors made by Evinrude Motors, Milwaukee, Wis.

Improperly labelled cans are detected and rejected by an electrically operated sensing device made by H. W. Wallace & Co., Croydon, England.

An alnico magnet imbedded in the rubber sleeve of a toaster plug holds the plug to the toaster and keeps the "wound-up" cord in place when not in use. Plug is made by Cord Caddy Mfg. Co., Fort Lauderdale, Fla.

A cast iron torque tube connects and aligns the aluminum side frames of the Ditto, Inc., offset duplicator.

Fig. 1—Geiger Torsiograph (left) showing tape drive, pen and light aluminum pulley. High inertia wheel within the cylindrical pulley and connected to it by a light spring rotates at constant average speed.

NOMENCLATURE

a — trough to crest amplitude for a sine wave, in.
D_g — diameter of gear, in.
D — diameter of take-off shaft or pulley, in.
e — eccentricity of gear, in.
k — reduction ratio of the gear reducer, dimensionless
M — pen magnification, dimensionless
N — A measured frequency, rpm
n — speed of take-off shaft, rpm
r — radius of Torsiograph pulley, in.
S — maximum per cent deviation from the average speed
t — time, min
v — velocity of the recording tape, in./min
y — instantaneous amplitude of pen movement on recording tape, normal to time axis, in.
α — maximum angle which the tangent to the Torsiograph curve makes with the time axis, deg
θ — angular displacement of Torsiograph pulley relative to the heavy mass connected to Torsiograph pulley, radians
ω — instantaneous angular velocity of pulley on Torsiograph, rad/min
ω_o — average angular velocity of pulley on Torsiograph, rad/min

Measurement and Control of Chatter in Gear Drives

Gear drive chatter is analyzed with the Geiger Torsiograph. Equations are developed for computing speed variations and eccentricity. General recommendations are given concerning gear reducers and drive motors.

C. E. ROSE and G. F. HADLEY
The Parlin Research Laboratory
E. I. du Pont de Nemours & Co.

THE GEIGER TORSIOGRAPH is a device for measuring vibrations and speed variations of gear drives. Although the Torsiograph is about 35 years old and has been used to great advantage in some fields, it is not widely known and has received little attention in the literature, except for a brief mention in Mark's Handbook and a short description in Den Hartog's book on Mechanical Vibrations. A photograph of the Geiger Torsiograph is shown in Fig. 1 and a schematic diagram in Fig. 2. Basic operating characteristics are as follows:

1. It accurately records chatter frequencies usually encountered in present day drives. Normal range of the Torsiograph used here is from 150 to 1200 cpm. This instrument can be used from 1200 to 6000 cpm if it is calibrated at the particular frequency with the same belt used in test. Other accessories for the Torsiograph are available which extend the range from as low as 30 cpm to as high as 10,000 cpm. However, the range 150-6000 cpm is almost always adequate.

2. A permanent record of speed variation is obtained.

3. It is possible to obtain quantitative results concerning speed variations, frequencies and eccentricities of drive components. Speed variations as low as 0.01 per cent can be measured with an accuracy of 10 to 15 per cent.

Instrument Operation

A light aluminum pulley is connected by belt to the mechanism under observation. Mounted concentrically with the pulley and connected to it by a light spring is a high inertia disk. A recording pen is connected to disk and pulley by a linkage mechanism in such a way that pen movement is proportional to angular dis-

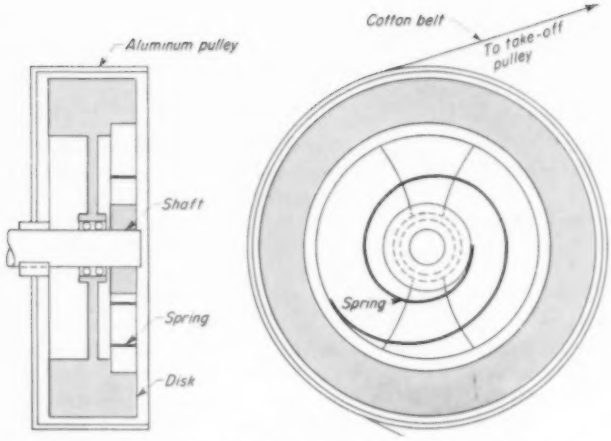


Fig. 2—Light aluminum pulley responds to speed variations of machine take-off pulley. A linkage drives pen proportional to difference in angular position of aluminum pulley and high inertia disk.

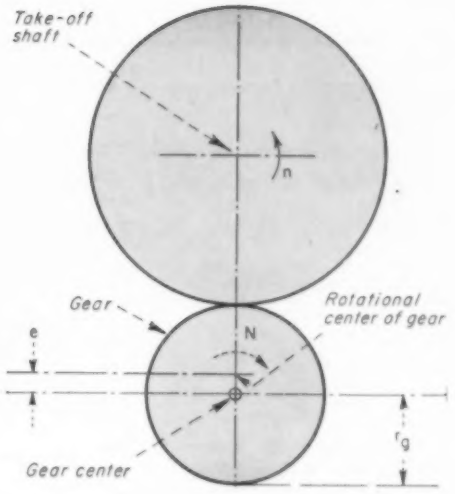


Fig. 3—Exaggerated drawing of an eccentrically rotating gear. Gear runs at N rpm creating a speed variation of N cpm.

placement of pulley relative to disk. Amplification of pen can be set for 3, 6 or 12 times. The pen is an ink recording type of low inertia.

Recordings are made on a paper strip which moves at constant speed in a direction perpendicular to pen movement; speed of recording tape can be varied from 1 to 40 fpm. A high frequency timing wave is recorded for a short interval once per revolution of the output shaft of the machine being tested. Frequency of timing wave can be adjusted to either 1500 or 3000 cpm.

A woven cotton belt is placed around Torsiograph pulley and take-off pulley mounted on the machine being tested. The Torsiograph pulley moves at instantaneous peripheral velocity of take-off pulley. The high inertia disk, however, revolves at average angular velocity because of its large inertia. A periodic displacement of Torsiograph pulley relative to disk results in a periodic curve traced on recording tape. This curve may be used to calculate speed variations of output shaft and frequencies of speed variations.

Basic Equations

Basic equations for obtaining quantitative results from the graphs have been developed. No such equations have been published previously in the literature, and they are not available from distributors of the instrument.

The Torsiograph pulley moves at intantaneous peripheral velocity of output shaft, while the heavy disk connected to it moves at the average angular velocity.

$$\omega - \omega_o = \frac{d\theta}{dt} \tag{1}$$

Movement of pen is proportional to displacement of pulley relative to high inertia disk, the factor of proportionality is magnification, M.

$$y = Mr\theta \tag{2}$$

Therefore maximum speed variation in per cent is given by:

$$S = 100\,\frac{\omega - \omega_o}{\omega_o} = \frac{100}{r\omega_o M}\left(\frac{dy}{dt}\right)_{max} \tag{3}$$

In actual measurements on tape, tan α is measured instead of $\left(\frac{dy}{dt}\right)_{max}$.

Where:

$$\left(\frac{dy}{dt}\right)_{max} = v \tan\alpha \tag{4}$$

Combining Eqs. (3) and (4):

$$S = \frac{100v}{r\omega_o M}\tan\alpha \tag{5}$$

Since $r\omega_o$ is average belt speed, Eq (5) can be referred to the output pulley by substituting πDn for $r\omega_o$.

$$S = \frac{100v}{\pi DnM}\tan\alpha \tag{6}$$

If the curve traced out on the recording tape is sinusoidal, the equation for the curve becomes:

$$y = \frac{a}{2}\sin 2\pi Nt \tag{7}$$

where N is the frequency of the wave on the Torsiograph and a is peak to peak amplitude. Differentiating:

$$\left(\frac{dy}{dt}\right)_{max} = \pi Na \tag{8}$$

Combining this result with Eq (3) and substituting πDn for $r\omega_o$:

$$S = 100\,\frac{a}{DM}\left(\frac{N}{n}\right) \tag{9}$$

In Eq (9), (N/n) represents the number of cycles of sine wave on recording tape per revolution of output shaft. If the sine wave is caused by a gear giving one cycle for each revolution of the output shaft then N, the speed of the gear, and n, the speed of the output shaft, are equal.

Gear Eccentricity

Assume a gear center moves around true rotational center at an eccentricity e. Maximum and minimum pulley speeds occur when gear center is on a line between rotational centers of mating gears as shown in Fig. 3.

If the gear rotates at an average N, (same as frequency of speed variation) peripheral pitch line speed will vary from:

$(\frac{1}{2}D_g + e)\,N$ to $(\frac{1}{2}D_g - e)\,N$

Peripheral speed change from maximum to average is eN and maximum per cent change in speed is given by the relationship

$$S = 100\,\frac{2e}{D_g} \tag{10}$$

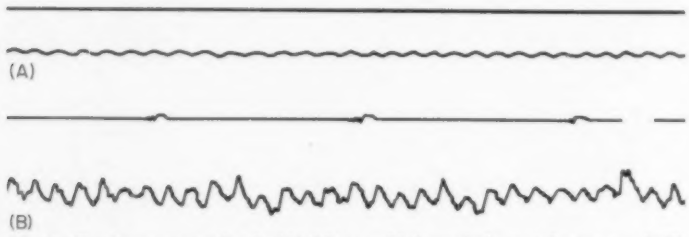


Fig. 4—Torsiogram records of: (A) Motor with bent shaft, coasting to standstill. (B) Motor with planetary gear reducer.

Combining Eq (10) and (9):

$$e = \frac{a}{2M}\left(\frac{N}{n}\,\frac{D_e}{D}\right) \qquad (11)$$

Similar reasoning applied to an eccentrically rotating take-off pulley with one side of the belt kept taut at all times results in:

$$S = 100\,\frac{2e}{D} \qquad (12)$$

and with Eq (9) remembering that now $N=n$:

$$e = \frac{a}{2M} \qquad (13)$$

Illustrative Examples

The Torsiogram of Fig. 4 (A) was recorded from a motor with a bent shaft. The Torsiogram was taken with the motor coasting to a stop so that electrical disturbances were eliminated. It is desired to compute shaft eccentricity and resulting speed variation.

$$D = 12.6 \text{ in.}$$
$$M = 12$$

Trough to crest amplitude

$$a = 0.0709 \text{ in.}$$

From Eq (9) with $N = n$:

$$S = \frac{100(0.0709)}{(12.6)(12)} = 0.047 \text{ per cent}$$

$$e = \frac{0.0709}{2(12)} = 0.0030 \text{ in.}$$

A more complicated diagram is shown in Fig. 4 (B). This is a torsiogram taken on a ¼ hp gearhead motor; gear reduction ratio is 9:1. Power was supplied from a power pack with full wave rectification. Determine recorded frequencies and speed variation at each frequency. Note that two distinct frequencies appear; a high frequency superimposed on a low frequency.

Using timing wave determine n, output shaft rpm of motor, and v, recording tape speed. Frequency of timing cycle is 1500 cpm; contact is made once every revolution of the output shaft. Distance between contacts is 2.54 in./rev. Distance that recording tape moves in one cycle of the timing wave is found by measuring distance between timer cycles in a given contact. This is 0.047 in./cycle. Then:

$$v = (0.047 \text{ in./cycle})(1500 \text{ cpm}) = 70.5 \text{ in./min}$$

$$n = \frac{70.5 \text{ in./min}}{2.54 \text{ in./rev}} = 27.8 \text{ rpm}$$

The low frequency measures 0.28 in./cycle or

$$N = \frac{70.5}{0.28} = 252 \text{ cpm}$$

Speed variation can now be calculated for the low frequency. Low frequency envelope is sketched in and assuming a fair approximation to a sine wave, amplitude is measured as

$$a = 0.29 \text{ in.}$$
$$M = 12$$
$$D = 12.6 \text{ in.}$$

$$S = 100\,\frac{a}{DM}\left(\frac{N}{n}\right) = \frac{100(0.29)}{12.6(12)}\left(\frac{252}{27.8}\right) = 1.74 \text{ per cent}$$

This result can now be compared with speed variation obtained by the tangent method. Taking average maximum slope of low frequency envelope as:

$$\tan\alpha = 3.21$$

$$S = \frac{100v}{DnM}\tan\alpha$$

$$S = \frac{100(70.5)(3.21)}{(12.6)(27.8)(12)} = 1.71 \text{ per cent}$$

which is in excellent agreement with the first method.

The high frequency $N = 0.0535$ in./cycle or 1330 cpm. The frequency of 1330 cpm is somewhat above the range of the Torsiograph without calibration. However, lack of precision in determining amplitude or slope of the high frequency wave probably outweighs the Torsiograph error at 1330 cpm. Both the slope and amplitude methods are difficult to apply to the high frequency wave. However, estimating:

$$\tan\alpha = 4.1$$

$$S = \frac{100(70.5)(4.1)}{(12.6)(27.8)(12)} = 2.2 \text{ per cent}$$

It is usually important to find the frequency in cycles per output shaft revolution (N/n) as well as cpm because if Torsiograms are taken at different speeds, it is possible to ascertain whether the frequency is due to power supply or geometry of motor or reducer. Torsiograms were taken at several different speeds on the above motor and it was found that the low frequency 9.1 cycles/rev. came through consistently regardless of speed. On the other hand the high frequency remained in the neighborhood of 1200 cpm independent of speed. One would immediately suspect that the 9.1 cycles/rev. came from the gear reducer since the reduction ratio was 9:1.

The reduction is a planetary type with three planet gears, a fixed internal gear and a high speed spur gear. Chatter frequency at output shaft for an eccentricity in any one of the above gears can be calculated in terms of reduction ratio.

Eccentric sun gear:
$f = 3(k - 1) = 24.3$ cycles/rev.

Eccentric planet gear:

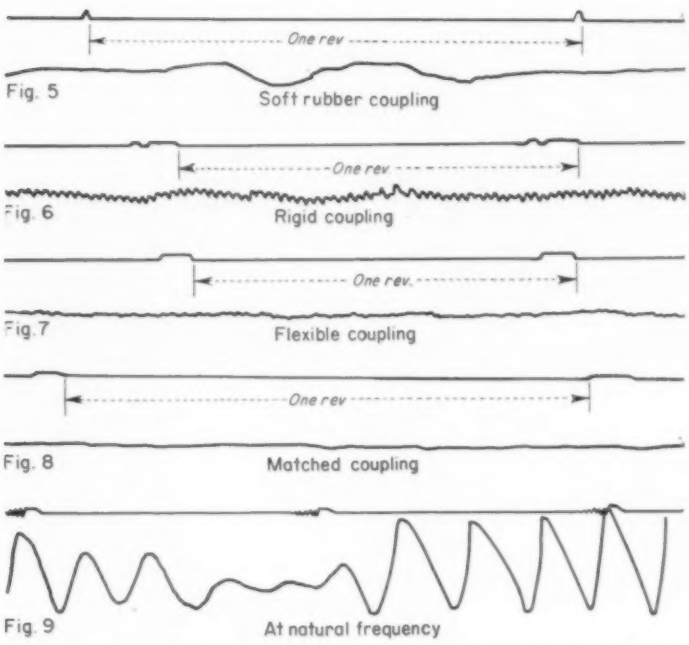
$$f = \frac{4(k-1)}{(k-2)} = 4.6 \text{ cycles/rev.}$$

Eccentric internal gear:
$f = 3$ cycles/rev.

Thus, on the basis of eccentricity, none of the gears appears to be responsible for the 9.1 cycles/rev. One way the 9.1 could be generated in the gear box would be for speed input shaft to rub against slow speed output shaft. However, investigation showed this to be physically impossible.

An oval planet gear would cause 2 x 4.6 = 9.2 cycles/rev. which is a possibility. Less likely, but still possible, is a slight distortion of the internal gear toward the shape of an equilateral triangle. Harmonics of all orders can be produced, and eccentricity is only one of the many errors found in gears.

High and low frequency speed variations might come from the motor itself. To investigate this further, an LC filter was placed between power pack and armature. Torsiograms taken after this change showed a re-



Figs. 5 to 9—Recorded speed variations of a motor driven worm type speed reducer with different couplings.

Fig. 10—Chatter caused by eccentricity in a helical speed reducer.

duction in amplitude of speed variation of both 1200 cpm and 9.1 cycles/rev., indicating that power pack ripple was associated with both.

Methodology

Some problems and difficulties may arise when using this instrument. The frequency being investigated must not be too close to natural frequency of disk. Extending the analysis in Den Hartog's book (pp. 43, 61, 75-80), for zero damping:

$$\frac{S_m}{S} = \left| \frac{\left(\frac{\omega}{\omega_n}\right)^2}{1 - \left(\frac{\omega}{\omega_n}\right)^2} \right| \qquad (14)$$

where S_m is measured speed variation, S the actual speed variation, and ω_n the natural frequency of disk. The disk, as normally used, has a natural frequency of 60 cpm, and so a speed variation with a frequency of 150 cpm will be correct within 12 per cent or somewhat better because of damping. Since precision of measuring wave lengths from record may not be better than 10 per cent, it is not necessary to apply the correction.

For frequencies below 150 cpm, it is best to change to a disk with a lower natural frequency. Eq (14) could be used as a correction, but since damping is unknown that is unreliable.

When more than one frequency is encountered it is sometimes difficult to determine what they are.

$$a \sin \omega_1 t + b \sin \omega_2 t \qquad (15)$$

is not a sine wave; and although periodic, it has neither the period ω_1 nor ω_2.

A particular case of (15) is:

$$\sin \omega_1 + \sin \omega_2 t = 2 \sin \tfrac{1}{2}(\omega_1 + \omega_2)t \cos \tfrac{1}{2}(\omega_1 - \omega_2)t \qquad (16)$$

in which frequencies

$\tfrac{1}{2}(\omega_1 + \omega_2)$ and $\tfrac{1}{2}(\omega_1 - \omega_2)$ appear.

In practice, however, a very high frequency is usually of small amplitude and a low frequency with larger amplitude. In these, the frequencies are easy to pick out. Two frequencies very close together and with beat notes do not appear often. Thus, the nature of frequencies which appear make analysis easier than might be expected.

Experimental Results

In Figs. 5, 6, 7, 8 Torsiograms are shown which were taken on a worm type gear reducer using different types of couplings. In Fig. 5 a Torsiogram is shown for a very flexible soft rubber coupling. There is practically no high frequency chatter from gears or motor, however, any small change in load resulted in large speed variations. A soft coupling is not suitable here.

A Torsiogram taken with a very rigid coupling is shown in Fig. 6. Gear tooth chatter is recorded. Every tooth in the gear is picked up. A very rigid coupling is not satisfactory either.

A flexible coupling of intermediate stiffness is shown in Fig. 7. All gear tooth vibrations show up, but speed variations are considerably reduced. This coupling is an improvement, but resultant chatter level is still not

Gear tooth chatter has been practically eliminated in Fig. 8. This was accomplished by adjusting flexibility of coupling so that the natural frequency of the system made up of coupling and driven roll was about 120 cpm. The change effectively stopped 1200 cpm disturbance from the gears. Fig. 9 illustrates oscillation at system natural frequency.

A helical gear reducer Torsiogram is shown in Fig. 10. Chatter is caused by eccentricity in the intermediate speed pinion. Helical gears never cause objectionable tooth chatter; eccentricity is the problem. Worm gears, on the other hand, always have tooth chatter.

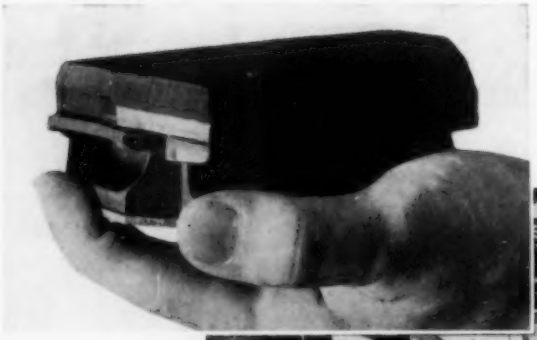
Summary

1. When chatter occurs in prime mover, insertion of a coupling with adjustable stiffness will reduce transmission of chatter to driven unit.

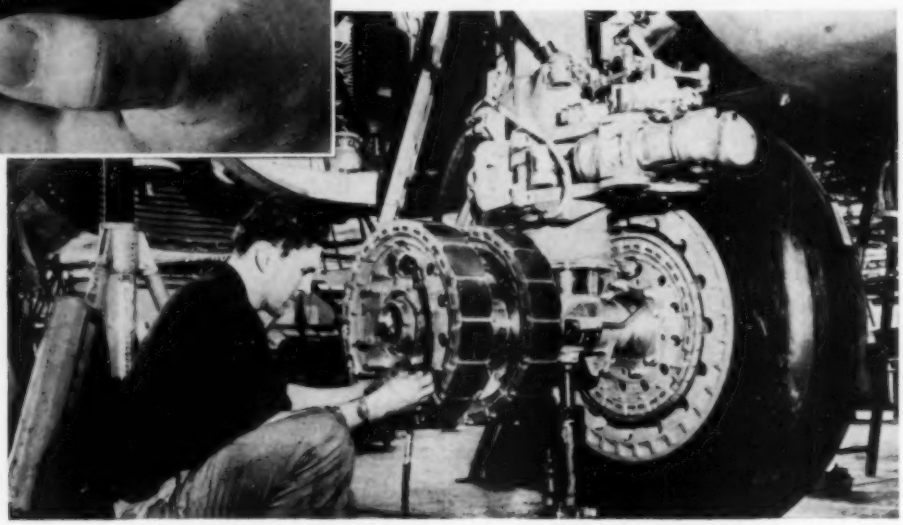
2. No standard worm reducer has been found free from tooth chatter.

3. No helical gear has been found with objectionable tooth chatter; gear eccentricity is the problem.

4. Full wave rectification for electronic speed control of motors is preferable. Even this may not give smooth operation if the armature is not magnetically as well as statically and dynamically balanced.



Expanding-tube brakes containing bands of floating silicone-lined shoes (left) are becoming standard equipment on many planes ranging from light sport planes to heavy transports.



Intense heat—up to 1500 F—developed at the brake lining surfaces during repeated stops should be insulated from the inner mechanisms of a brake.

One way to insulate the linings is to use . . . Silicone

A. P. BETTICK
Project Engineer, B. F. Goodrich Co.

ONE OF THE CRITICAL PROBLEMS in brake design is the dissipation of intense heat that is generated by the brake linings during operation. Usually the heat is insulated from the hub and inner mechanisms of the brake by brake linings made of asbestos compounds. The heat then flows outwardly to the steel drum where it dissipates into the air.

However, to meet rigid performance requirements on certain aircraft, the brake specifications were changed to call for linings made of sintered metal. The brakes are of the expanding tube type, illustrated in Fig. 1, in which a tube made of neoprene-rayon encircles the hub like a tire rim or wagon wheel. Actuated by hydraulic pressure, the tube presses out against a series of brake shoes, to which are attached sintered metal linings which, in turn, press against a steel drum.

Flat springs under the lips of each shoe force the shoes away from the drum when hydraulic actuating pressure is released. Since the shoes float with only the spring coupling the shoe to the brake, the many lining segments conform to the friction surface even if heavy braking forces result in some distortion to the drum. Torque bars attached to the body of the brake separate the lining segments, and transfer torque from the friction surface to the fixed axle of the airplane.

Use of sintered linings solved the brake performance as required, but introduced a heat problem. No longer could the linings be depended on to insulate the expander tube from the brake heat, so a practical heat barrier had to be provided.

It was found in repetitive stop tests, in which a fully-loaded airplane taxis and stops at full speed five times within a half-hour, that temperatures inside the brake linings reached about 600 F during the first stop, 700 during the second, and so on until the last stop generated over 1500 F. Much of this heat flowed inwardly where it soon deteriorated the expander tube to the point of failure. Maximum temperature that the rubber expander tube could endure, even temporarily, was 500 F. New materials were tried as a replacement for the rubber tube but proved unsuccessful, and the problem reduced to that of finding a new material for the brake shoes. The original shoes were made of magnesium; what was needed was a strong, easily formed, light-weight material, which could reduce the transferred temperature from 1500 F down to 500 F in one inch.

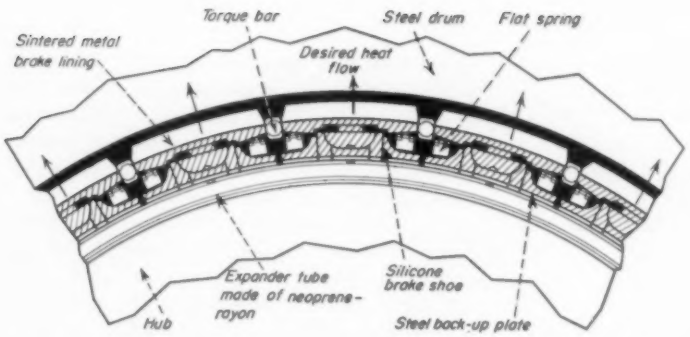


Fig. 1—Details of an expanding-tube brake assembly. Use of sintered metal instead of an asbestos compound for brake linings permitted heat to flow inwardly when the brake was applied. Solution: brake shoes made of silicone compound.

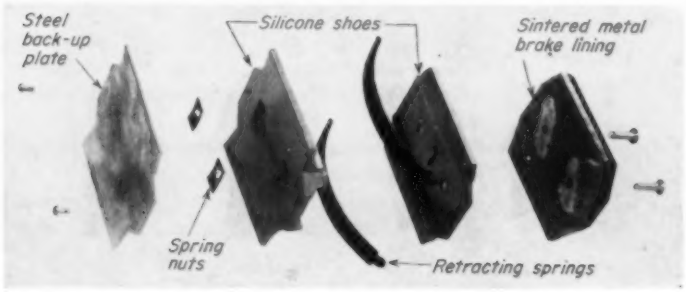


Fig. 2—Exploded view of the brake shoe assembly.

Shoes for Brakes

The screening test was quite simple. A section of the sintered lining was clamped on a sample of proposed brake shoe material. A thermocouple was located between them and another on the opposite side of the shoe. A blowtorch was played on the sintered lining until the inner thermocouple indicated 1500 F. If the temperature of the other thermocouple simultaneously read 500 F or less, the material was ready for further consideration.

Few of them were. Of the 30 or more materials tried, many were too heavy, and a few, such as the ceramics, exhibited poor shock resistance. Others weakened rapidly at high temperatures. The material which met all the requirements was relatively new; a dry silicone resin filled with chopped glass fibers (Dow Corning 301 Molding Compound).

Shoes made of this material were just as light as the original magnesium shoes; they retained almost their full physical strength at high temperatures, and when fully cured did not smoke. The only drawback to the compound, aside from its cost was its newness on the market and its consequently unfamiliar handling properties and molding characteristics.

Design Details

Although the magnesium shoes had been simple cut-off extruded sections, the silicone shoes are molded in two parts, as shown in Fig. 2. Brake lining is fastened through the top. Even though the molding is comparatively strong, a steel back-up plate is riveted under the bottom section to prevent the powerful retracting springs from cracking the bottom lips off, as well as to prevent the expander tube from extruding into the shoe under pressure.

Shoes were first designed with two interior bosses on the bottom section into which retaining screws for the top section and lining were fastened. However, tests showed that the compound alone would not hold the screws. Minimum test pressure to pull the lining loose was set at 500 lb; the linings would pull out at 200 lb or even less. The design was changed to a heavier concentration of mass at the center. Holes were drilled for self-holding screw retainers, but these also pulled out all too often at less than 500 lb. After some experimentation with threaded inserts, the design was changed to take advantage of the high compression strength of the compound at elevated temperatures. Bolt holes are drilled all the way through both shoe sections and bolts are held by spring nuts recessed into the shoe. When pull test readings on this design reached the 1,400 lb range, the assembly was considered satisfactory.

Molding Details

In molding the parts, rectangular preforms are made in conventional preforming equipment, reducing compound bulk to one-third of cavity volume. Twelve pieces per cycle, six tops and six bottoms, are compression-molded between chromium-plated dies at a pressure of 5,000 psi. The molds are equipped with strip heaters to maintain a temperature of 350 F. The press cure takes 7 or 8 min and the molded parts are baked overnight at 480 F to completely remove all volatiles.

Over 50,000 of these shoes have been put into service. Sixteen shoes are used on each 21-inch brake, giving a 95 per cent contact surface with the brake drum surface. Two brakes are fitted on each wheel.

The brake drum is manufactured from roll-forged high tensile steel and slotted to permit thermal expansion to occur without distortion of the drum. Hub and spider are manufactured of magnesium. The expander tube is activated with "red oil" hydraulic fluid (Military Specification MIL-0-366). Maximum operating pressure is 800 psi.

High strength-to-weight ratio, heat resistance, non-flammability and most of all, heat-insulating characteristics makes silicone molding compound an important structural material for future brake and clutch designs.

HYDRAULIC CONTROL VALVES

I—Relief Valves

Basic academic theories of fluid flow and Pascal's laws relative to the behavior of contained fluids are familiar. The mathematical relationships do not change. Pumps or pressure generating devices are generally well described and rated. as are cylinders and fluid motors.

Valve operating characteristics are less well known, however. Capacity and pressure ratings may not mean the same things to manufacturer and user. The misapplication of hydraulic valves has cost industry untold thousands of dollars in inefficient heat generation and lost power.

This series of articles is intended to cover the identification, function, construction, installation and maintenance of valves in relation to the circuit as a whole and to help in analyzing and predicting malfunction and making satisfactory correction. In some instances it may be of assistance in tailoring a valve to a specific application.

The three major valve types—pressure control, flow control and directional control—will be considered in that order. A wind-up article is planned to include material about certain specialty items like the hydraulic fuse, multiple control valves that are really valves in a common housing and special systems like high-low and regenerative circuits.

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THE RELIEF VALVE is a device that automatically creates an orifice sufficiently large to divert fluid back to the reservior at a predetermined value of pressure. The ideal relief valve would permit pressure to rise to the set value and then create an orifice to maintain that pressure. This ideal is not economically feasible so units used as relief valves are designed to operate at some degree less than the ideal condition according to the economic requirements of the circuit involved.

Simplest type of true relief valve is a sliding spool normally closed two-way valve which has one end of the spool connected to the input line and the other end loaded with a simple coil spring as shown in Fig. 1. The pocket in which the spring is enclosed is drained to the downstream or tank connection and back to the reservoir. The spring positions the spool so that the input line is blocked from the exhaust line. As input line pressure increases, oil pressure against the end of the spool tends to move the spool against the opposing spring. The primary, or pressure port of the valve is gradually opened to the secondary or tank port so that an orifice is created directing the oil back to the reservoir.

Size of orifice created is directly dependent on effective area on the end of the valve spool, spring rate, and amount of fluid flowing through the orifice.

Some refinements to this basic relief valve include angles

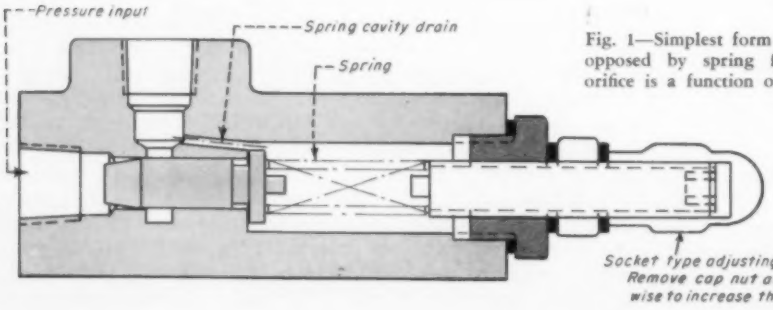

Pressure input
Spring cavity drain
Spring
Socket type adjusting screw: Remove cap nut and turn clockwise to increase the pressure

Fig. 1—Simplest form of relief valve. Fluid pressure is opposed by spring force. Pressure drop across the orifice is a function of flow through the orifice so that pressure at which the relief valve cracks open will be somewhat lower than that needed to dump a rated maximum flow of fluid. Maximum flow is 1 gpm.

A Short Course in Hydraulic System Design

Many papers, articles and books have been published in an effort to familiarize the reader with efficient hydraulic circuits. There are scores of more or less standard circuits that have performed excellently in specific machines. Certain basic segments of these circuits are common to many and often may be purchased as a multiple component incorporating pump, control valving and even fluid motor in a single package.

Standard circuits are convenient but they, too, may be misapplied. Each new problem should be approached with the following questions.

Does the job economically justify use of fluid power? A thorough knowledge of cost versus performance of oil hydraulic, pneumatic and mechanical transmissions is required to make this decision. It is necessary to be extremely cautious to overcome the natural temptation to apply new found knowledge uncritically.

What forces and speeds are required in the operation. Force is pressure times area. Small spaces (and areas) require higher pressures. Speed is equivalent to flow (gpm or in.^{3}/min). Pumps and fluid motors or cylinders may now be specified.

Control valves are chosen in a similar way. Pressure ratings must match maximum pressures generated by the pump unless rapid movements will involve shock waves. Flow capacity through the valve will be based on capacity of pump with the exception of regenerative circuits or those using accumulators.

Valves may be divided into three major categories. Pressure control valves are chosen to meet the needs of the pressure generating equipment in relief and safety functions, sequencing, unloading, counterbalancing, etc. Flow control valves control speed of fluid flow and are selected according to the degree of sensitivity required and quantity of fluid handled. Directional control valves are chosen to suit the operating signal (manual, cam, solenoid, pilot) and the type of control desired such as two-way, three-way, four-way or any other multiplicity of control needed. Many variations such as spool notches, taper grinds, reliefs, etc., are available as refinements of the direction control function.

Having chosen the circuit and its components, design proceeds to plumbing, reservoir and physical placement of components for maximum efficiency and ease of maintenance. Improvements in high pressure plumbing and connectors in the form of flanges and subplates have eased maintenance and increased customer acceptance to a very satisfactory level.

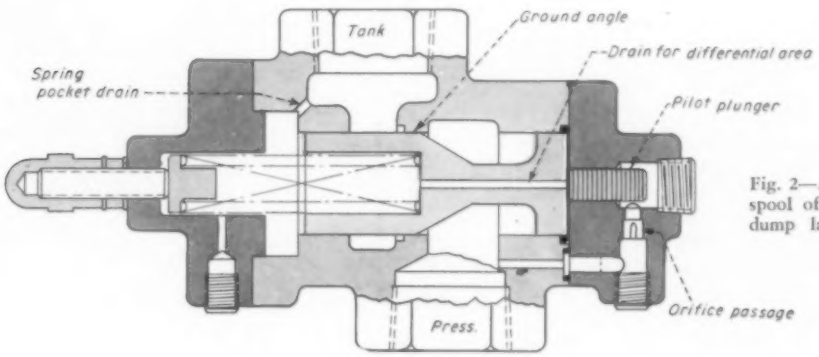


Fig. 2—A pilot piston actuates the spool of this relief valve used to dump larger quantities of fluid.

ground on the spool, orificed passages to the pocket at the end of the spool, orifices in the drain line from the spring pocket, and pilot pistons instead of pressurized fluid to work against the end of the spool as shown in Fig. 2. Use of pilot pistons is often necessary to keep the effective pilot pressure area within the physical range of practical spring rates. When a pilot piston is used, it is necessary to drain the pocket between pilot piston and end of the spool because of the difference in areas. Sometimes this pocket is drained through a hole in the center of the spool which conducts fluid to the drained spring chamber.

Pressure range is usually quite narrow with this type relief valve because of the inherently narrow spring ranges that can be accommodated in the relief valve housing. In some applications it is necessary to nest several springs to obtain the desired spring rate.

Relief valves may be constructed with a stepped spool of two different diameters in a housing with both end pockets drained as shown in Fig. 3. The larger diameter is toward the spring pocket. The larger diameter is also between the input or pressure port and the outlet or tank port. The net difference in area between the two concentric diameters acts like a pilot piston.

Operating Characteristics

Direct spring loaded relief valve design, while simple in construction, has many drawbacks. The range of adjustable pressure is usually quite narrow. In addition, the valve does not fail safe. If an orifice is plugged with foreign matter the valve fails to open permitting an overpressure condition. There is a tendency, unless highly damped, for the valve to chatter or hammer in response

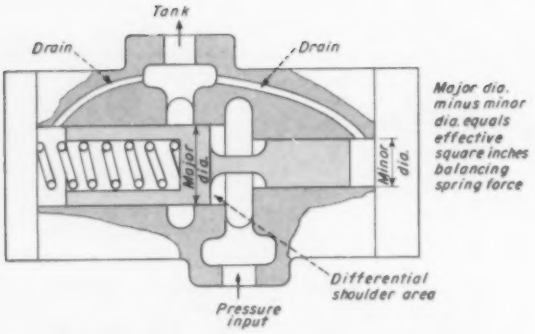


Fig. 3—Net area between minor and major diameters is the effective area against which pressure acts in this relief valve. Both ends of the spool must be drained to tank.

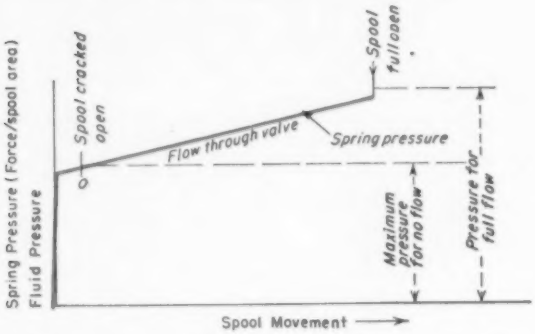


Fig. 4—If full pump capacity is dumped through the relief valve with the spool full open it may take a considerable drop in applied pressure to reduce the tank flow to zero.

to rapid changes in circuit requirements. Sometimes this is the result of harmonics set up in the spring.

Any restriction in the line to the reservoir will increase the effective spring values so that the operating pressure will be higher. In certain applications it is common to connect returns from several different devices to a common return header. Pressure in this header will increase with large tank flows which, when reflected back to the relief valve, cause an increase in the entire circuit pressure. Therefore, individual and independent lines to the reservoir are desirable where economically feasible. Independent tank lines are also convenient in tracing down circuit losses.

Spring loaded relief valves are inherently variable orifice devices as shown in Fig. 4. The spring requires a definite increment of pressure between barely cracked and full open. An 18 gpm pump might direct its full volume through the valve in certain parts of a machine cycle. At 1000 psi the relief valve has established a maximum orifice. However, if work resistance during some other part of the cycle created a pressure of 900 psi a portion of the flow may still be by-passed to tank through a partly open orifice. Some valves do not entirely close until pressure drops to 50 per cent of the relief valve setting.

Often this loss is unimportant. Some machines use the effect to intentionally slow operation as work resistance increases. When pressure reaches the set value the valve

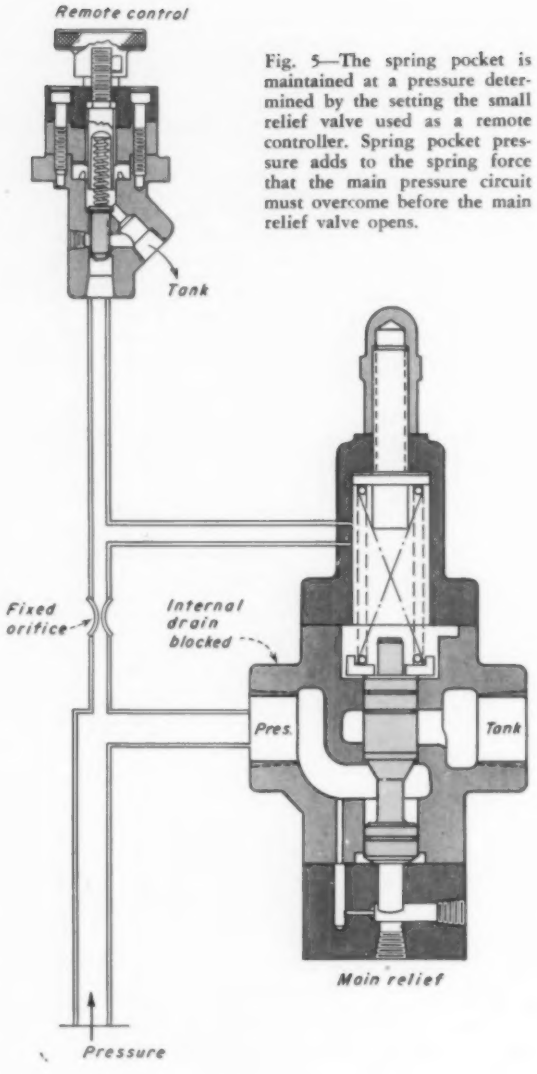


Fig. 5—The spring pocket is maintained at a pressure determined by the setting the small relief valve used as a remote controller. Spring pocket pressure adds to the spring force that the main pressure circuit must overcome before the main relief valve opens.

is full open and the machine stops entirely. However, a penalty in efficiency is paid for this type of bleed-off speed control.

The piloted poppet relief valve is perhaps the most accurate and efficient relief valve for all around use on hydraulic applications. In some cases it is higher priced on initial applications but usually saves in operating costs.

Pilot Operated Relief Valves

Operating pressure of the spring loaded valves may also be controlled remotely as shown in Fig. 5. If a small amount of oil is diverted from the pressure port through an orifice of proper size into the spring chamber, and the drain from the spring chamber is diverted through a small pilot type relief valve, an addition to the spring force is created. The pilot valve can be placed remotely from the main valve. An established minimum pressure is assured by the main spool spring, any higher value within the scope of the equipment may be reached by the added

hydraulic pressure in the spring pocket. This type of control is used when a fixed minimum pressure is necessary with varying maximum pressures.

Compound construction is characteristic of pilot type relief valves. The basic two-way portion of the valve may be either sliding spool or poppet type construction, with a multiplicity of concentric diameters to create desired balancing factors as shown in Fig. 6. Minimum pressure is established by a spring. An orificed passage is provided from the input or pressure port to the spring pocket, or to an annular pocket, called the control chamber. An additional passage is provided from the control chamber to a pilot relief valve. This pilot relief valve can be in the form of a small spring loaded ball or cone. It can also be in the form of a sliding spool. The pilot relief valve is relatively independent of the main portion of the valve as far as physical position is concerned but most pilot operated relief valves have the pilot section built into the cap or directly manifolded to the valve.

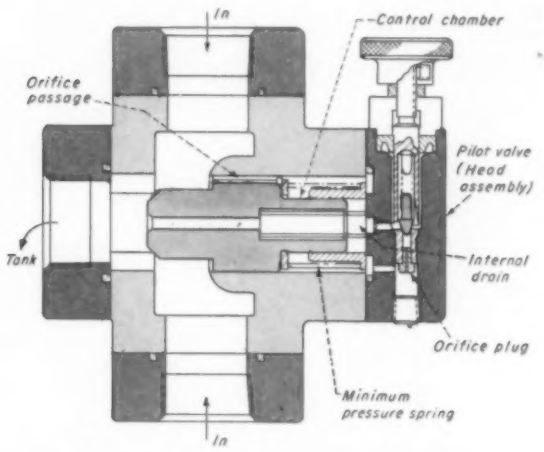


Fig. 6—Compound valve in one housing whose operation is similar to that of Fig. 5. Only an annular portion of the main piston area is used for added hydraulic pressure in the spring pocket. Note two orifices; between main circuit pressure and spring pocket, and between spring pocket and pilot valve cone.

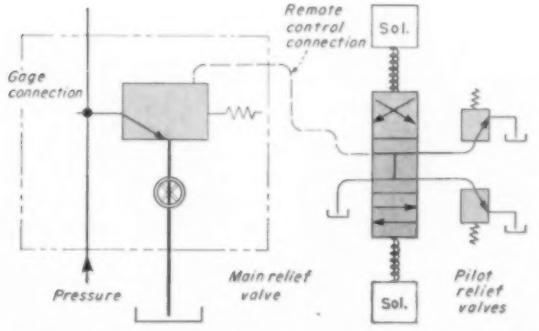


Fig. 7—A solenoid controlled four way valve chooses the manner in which the spring pocket is connected to tank. It may be either direct connected or go through either of two differently set pilot relief valves. Any one of three maximum relief settings may be chosen.

Many different pressures can be established for a single basic relief valve by directing oil to various pilot chambers at different pressure settings. A definite program can be set up in circuits where varying pressures are desirable by the process of diverting the oil to different pilots as shown in Fig. 7.

The basic valve body usually has a minimum pressure value of less than 100 psi. This pressure will dump main circuit oil when pilot oil is released to tank without restriction. At pressures over 2000 psi the initial pressure (established by spring rates) may be increased for quick response. A minimum pressure of approximately 10 per cent of maximum pressure is common in commercial valving.

In addition to the relatively quiet and dependable service that can be expected of the piloted type relief valve, versatile controls can be tailored to a multitude of applications as shown in Fig. 8. Small pilot relief valves can be controlled by an adjusting screw and locked after setting, levers permit quick manual change of pressure, a cam roller type unit can sense pressure requirements from machine operations and diaphragm units can sense and amplify minute changes in air controls or low pressure hydraulic circuits.

The most common remote control for piloted relief valves is the adjusting screw type as shown in Fig. 8 (E). Two or more pilot valves can control flow from the main pilot chamber. An integral pilot control is adjusted to control pressure between control chamber and tank and is set for any desired maximum pressure. A remote valve will control for any pressure less than maximum. The integral pilot control valve is in parallel with auxiliary remote control valves. The unit with least resistance to fluid flow is the effective control.

Physical location of remote valves should be within 20 ft of basic relief valve because of frictional losses in passage of pilot oil through the lines. Special units and adjustments can increase this maximum distance.

In some circuits needle type two-way valves are used as remote control for a relief valve. Pressure can be controlled accurately in this manner. In all cases discharge from the remote control valves must be connected back to the reservoir without resistance if the pressure control is to be consistent.

Rapid drop in operating pressure to the established minimum is possible by allowing the control chamber to drain without restriction to the tank. A two-day valve in parallel with the maximum pressure adjustment pilot control valve will perform this function. When the two-way valve is open to the reservoir, pilot oil is released and the pressure drops to the established minimum. When the two-way valve is closed the oil is diverted from the control chamber through the pilot pressure control unit to tank. Maximum pressure will then be a function of the established setting of the remote or integral control pilot valve or the resistance of the work being performed.

Fig. 9 illustrates a standard lever operated four way valve with detents to hold the spool in one of three positions at the will of the operator. The end cap has been replaced with a two way valve housing. The spool for the two way portion is fastened to the end of the four way directional spool so that the two will operate simultaneously.

When the valve is in the neutral position the in and

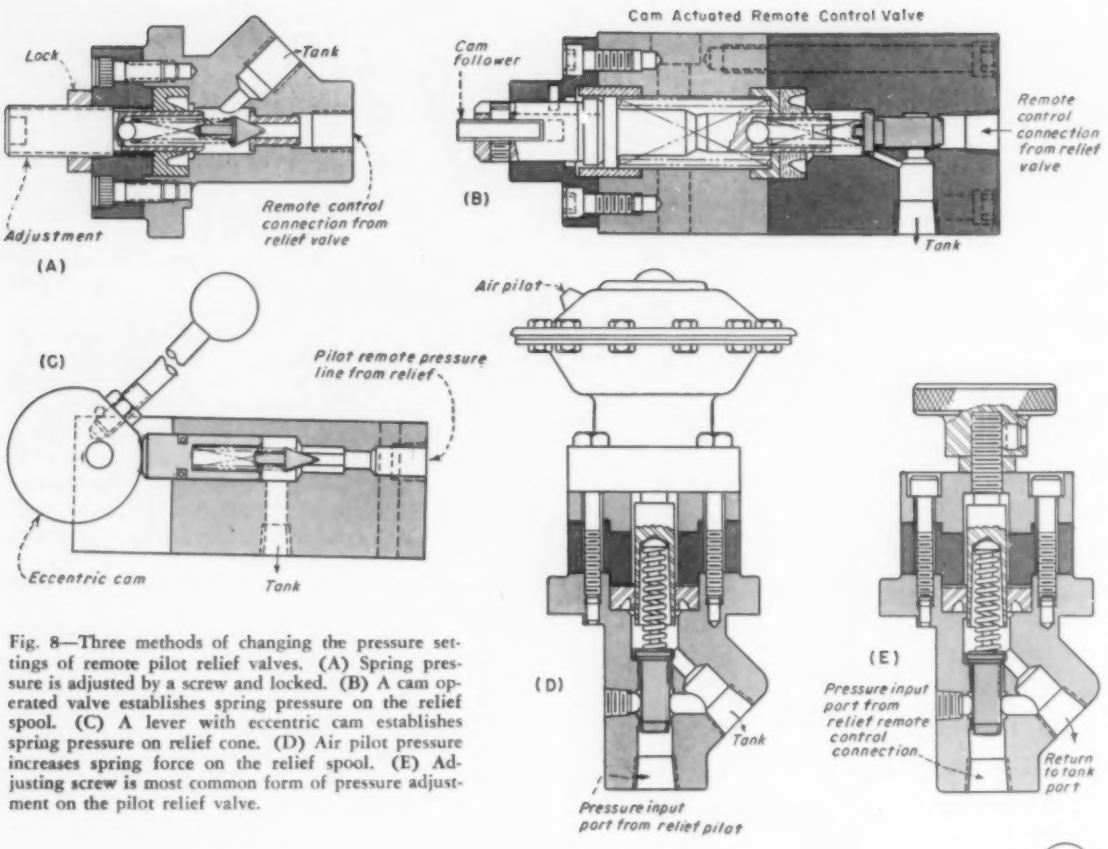


Fig. 8—Three methods of changing the pressure settings of remote pilot relief valves. (A) Spring pressure is adjusted by a screw and locked. (B) A cam operated valve establishes spring pressure on the relief spool. (C) A lever with eccentric cam establishes spring pressure on relief cone. (D) Air pilot pressure increases spring force on the relief spool. (E) Adjusting screw is most common form of pressure adjustment on the pilot relief valve.

out ports of the auxiliary two way valve are connected. The out port is connected to the reservoir and the in port is connected to the remote control port of the relief valve. Thus the control chamber in the pilot operated relief valve would be directed back to tank or relaxed. This diversion of the control oil back to the reservoir will drop main relief valve pressure down to the minimum as established by the main spool spring.

When the four way valve is shifted in either direction, flow through the two way valve is stopped. The relief now functions in the normal manner, raising pressure to the resistance value of the circuit or to the maximum pressure setting of the integral pilot in the event that the entire volume is not being used to move a machine member. Auxiliary two way valve sections are available in many different types and sizes of directional control valves.

It is possible to connect several valves in series as illustrated in Fig. 10. The directional control valves can be in a parallel circuit and the relief valve pilot lines connected in series through the two way sections. This permits using a valve of a limited size for directional control without minimizing the flow during the unloaded portion. All unloading is done through the piloted relief valve.

If a pilot valve is installed in the remote control line between two valves as illustrated in Fig. 10 it will determine maximum pressure while valve *B* alone is being used. When valve A is used the system will have the full pressure as set on the main relief valve. In this manner it is possible to cascade pressure values down through several settings.

One large installation used a 90 gpm pump with a 2 in. relief valve to supply oil to the circuit. The valve controlling the main winch was of a two inch pipe size. Maximum pressure was needed for the fluid motor driving the winch. A tailgate mechanism needed a lesser pressure and only a ¾ in. directional control valve. An auxiliary bulldozer needed only a minimum pressure but 1¼ in. pipe.

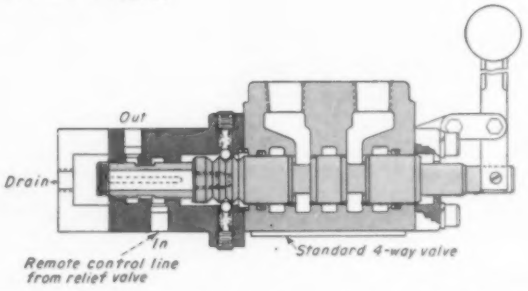


Fig. 9—A two-way valve with open center is here integral with a standard four-way valve. The two-way valve may be used to pilot a relief valve spring pocket to tank, effectively lowering pressure setting during idling of a hydraulic circuit.

The three two-way segments were piped in series. The first connection from the relief valve remote control line was to the winch control valve. The discharge from this two way section was directed to the input of the tailgate valve. In this line a remote control valve was connected that controlled the maximum pressure on the tailgate. The out line from the tailgate two-way valve was connected to the bulldozer valve assembly with a suitable remote control valve ahead of the two-way section to control the maximum pressure developed while the bulldozer mechanism was being used. This provided a simple and effective circuit at a minimum cost.

Electric Control

Two-way valves used to remotely drop the pressure to the established minimum can be lever operated, cam operated, stem operated, or electrically operated. Relief valves of the piloted type may have solenoid operated two way valves built integral with the valve so that the solenoid can be integrated in the electrical circuit to drop pressure between cycles as shown in Fig. 11. Many circuits can be simplified and made much more dependable in this way. Space requirements and piping costs are obviously reduced by the integral solenoid pilot valve.

Some variations of this basic design include normally closed spools in the pilot valves for circuits that require a solenoid to be energized to drop the pressure, and dual pressure control heads so that two pressures are available with the solenoid acting as the shifting medium between the two pressures as shown in Fig. 12.

If the pressure control chamber is allowed to bleed back to the reservoir without resistance and faster than oil can enter the control chamber through the orifice, the pressure is equal to the force created by the spring on the main spool. If this bleed is blocked and oil is directed to the normal integral pilot, operation is conventional. If the two-way valve is made a part of the relief valve assembly piping and pressure drop are reduced.

These valves are usually provided normally open so that pressure controlled by the relief valve is at its minimum value until the solenoid is energized.

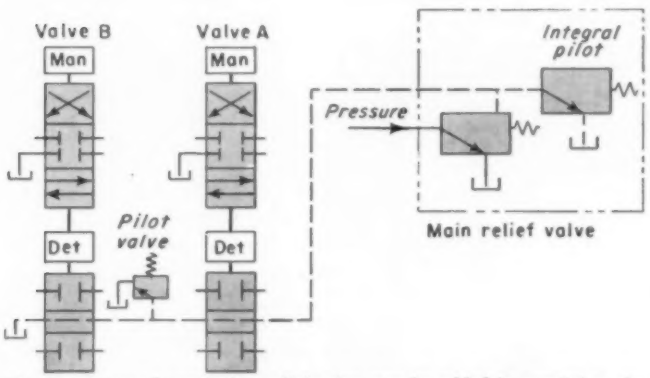


Fig. 10—A second small pilot relief valve may be added in parallel to the one built into the main relief valve. When four-way valves *A* and *B* are centered, lowest relief valve setting is made by dumping the relief spring pocket to tank. When valve *B* is off center the main relief valve is controlled by the auxiliary pilot valve. When both *A* and *B* are off center the relief valve operates normally with its integral pilot relief valve.

Sample Applications

Accumulators that operate with a weight or spring offer a physical movement to sense the charged and discharged position. It is simple and economical to have limit switches at the desired extreme positions to actuate a solenoid operated relief valve and control the recharge cycle Usually it is much less expensive to run electrical conduit and limit switches rather than pilot piping. An important factor is the normally greater protection from mechanical injury to the connecting

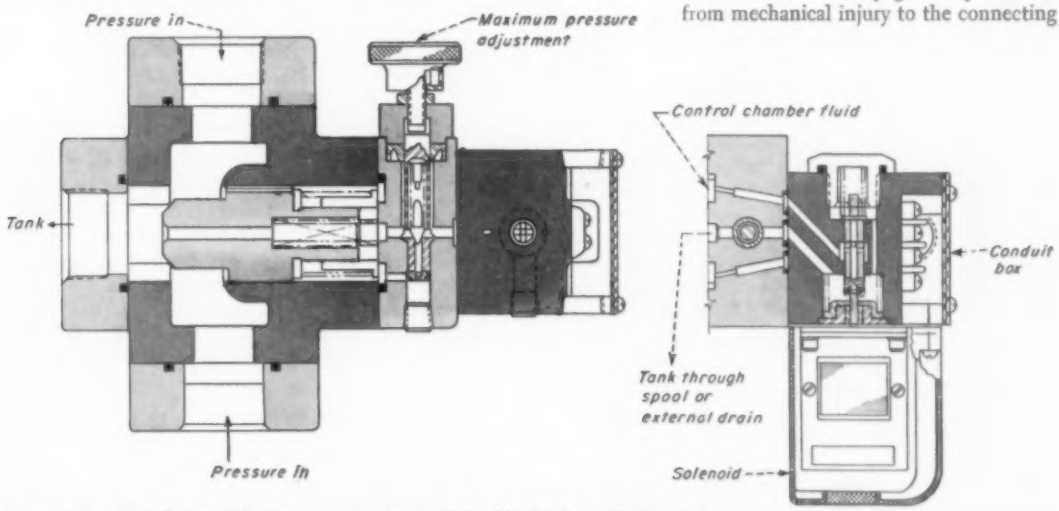


Fig. 11—A solenoid operated two-way valve in parallel with the integral pilot valve permits dumping the spring pocket to tank in response to an electrical signal. Drawing at right is a section through the pilot heads rotated 90 degrees.

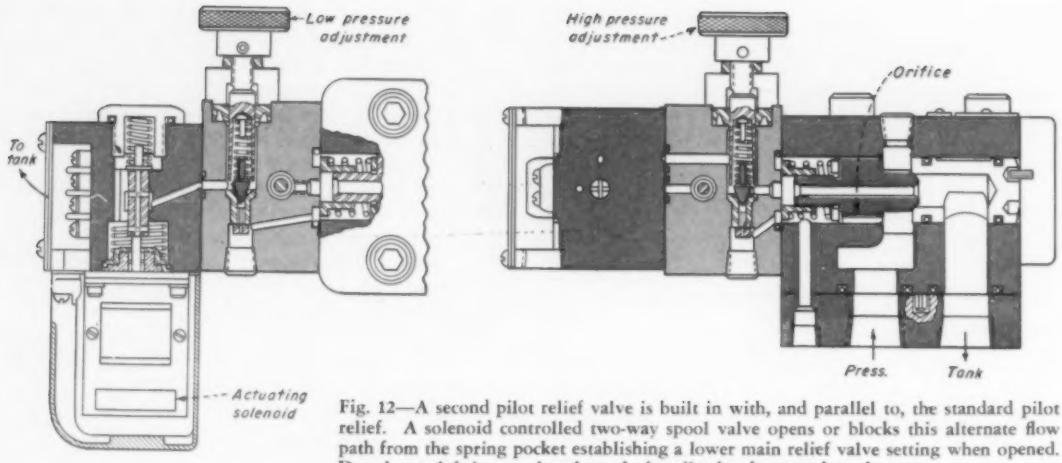


Fig. 12—A second pilot relief valve is built in with, and parallel to, the standard pilot relief. A solenoid controlled two-way spool valve opens or blocks this alternate flow path from the spring pocket establishing a lower main relief valve setting when opened. Drawing at left is a section through the pilot heads rotated 90 degrees.

media when electrical devices are used.

Accumulators using gasses as a balancing medium or so constructed that physical movement cannot be used to sense the amount of charge must, of necessity, depend on pressure for a signal. In this application a pressure switch with an adjustable maximum pressure as well as an adjustable minimum pressure can be used to actuate the solenoid operated relief valve to control the pumping cycle for recharging the accumulator.

In some circuits the solenoid control is used for establishing two different adjustable pressures. These models have two independent pilot relief valves manifolded to the main relief valve body incorporating a solenoid operated diversion valve for control as shown in Fig. 12. With the solenoid de-energized, the primary pressure control head establishes a certain pressure at the desire of the operator. When the solenoid is energized the primary head is removed from control and the secondary head takes over as the control medium. The secondary head must always be set at a higher pressure than the primary head or the control will be nullified. On certain types of spinning and metal forming machines this valve provides a medium or low pressure for delicate operations and a higher pressure for coining or other operations during the cycle when additional pressure is necessary. If there is some question as to the amount of back pressure that may be encountered in the secondary or tank port of the relief valve it is usually advisable to specify externally drained models. If the tank line is relatively short and the volume is well within the rating of the valve, external drains are not essential.

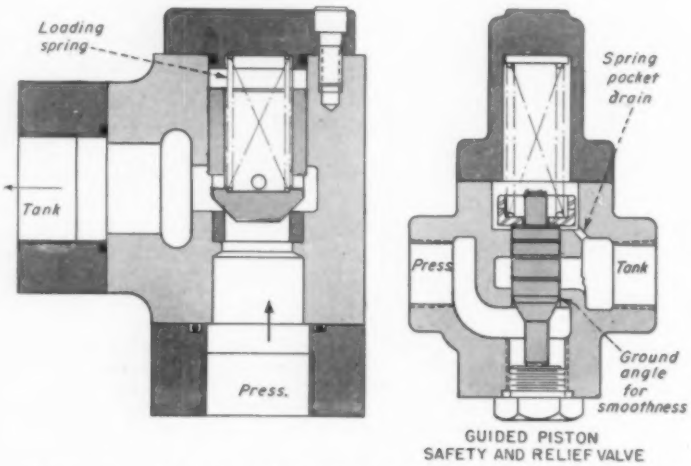


Fig. 13—Simplest safety valve (left) in which cone lifts off seat when pressure equals spring force. Holes in cone are to drain the spring pocket. (right) A guided piston safety valve. The spring pocket drains to the tank port through an orifice used to damp out spool oscillations without adversely affecting speed of pressure actuation.

Many automation devices operate at relatively low pressures during a large portion of the time cycle. As an example, the index, positioning and locking portion of a machine cycle may only require 200 psi. The automatic insertion of a sleeve bushing may require as high as 1000 psi. In this cycle a dual pressure solenoid operated relief valve might be used. During all portions of the cycle with the exception of the pressing operation the pressure is held at a maximum of 200 psi by the dual pressure relief valve. As soon as the circuit is actuated to bring in the pressing cylinder the solenoid operating the relief valve pilot diversion spool is energized. Actuating or energizing the solenoid on the relief valve provides a pressure setting of 1000 psi instead of the previous 200 psi.

Other reasons for limiting the pressure may be as safety precautions, power saving, easier control, preventing intensification during certain dynamic operations or to limit forces on certain tooling. At the desired point in the circuit the pressure can be changed by an electrical signal to any higher value desired, within the scope of the equipment involved.

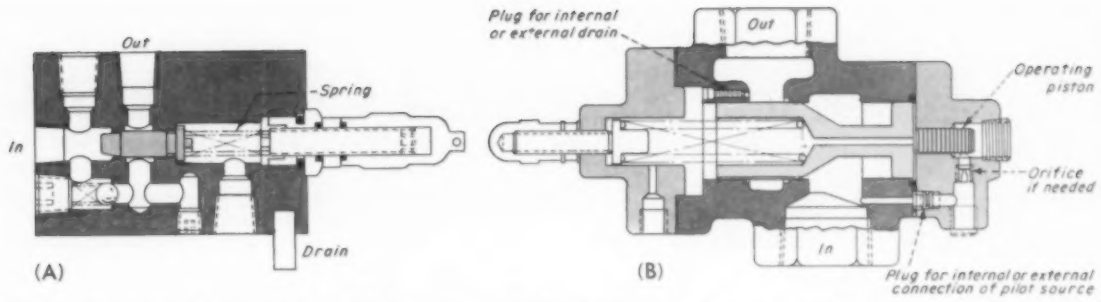


Fig. 14—Two forms of bypass valve. (A) is direct spring loaded and operated by the pressure at the in port. (B) may be actuated by pressure at the in port or by a remote pilot line. Damping provisions are also included.

BYPASS VALVES

If the relief valve were only in the circuit for protection against undesirably high pressures and operating pressure were considerably lower than the setting of the valve it might be considered a safety valve. As a safety valve, operation only occurs because of some improper functioning of the machine. However, construction of a safety valve might be considerably simpler than a true maximum pressure relief valve. It might also be desirable to have the safety valve create noise in the form of a chatter or whistle to alert the operator when the valve is in operation.

In many installations the safety valve is a simple ball check with a heavy spring to hold ball against seat. At pressures sufficiently high to unseat the ball a path is created back to the tank for this excess fluid. No orificing or damping action is provided so that the operation is erratic and often very noisy. Since the device only operates in an emergency the noise is relatively unimportant. Two variations on this design are shown in Fig. 13. Low first cost and dependability are the primary criteria in choosing the true safety valve. Choice of a relief valve usually involves many more factors such as quietness, dependability, repetitive accuracy, versatile remote control, smooth passage through valve and metals which will last a long time in severe service.

There are two basic types of bypass valves. Probably the most widely used is the direct spring loaded type shown in Fig. 14 (A). This is a normally closed two way valve with a spring on one end of the spool balanced by a piston on the other. This piston may be the end of the spool or some separate actuating medium such as an integral piston of a different diameter or a diaphragm for amplification of pressure signals as in (B). This actuating piston may be connected to the input line internally with or without a restricting or damping device. If operating signal is taken from the input or upstream side, position of the spool is directly related to input pressure; relief, safety or internally piloted sequence valves operate in this manner.

If this pilot piston device is connected to some external fluid pressure signal point it is an externally piloted unit. Pressure at the in port of the valve has no effect on operation of main spool. This type of pilot connection is used in most unloading circuits, some counterbalancing circuits and some sequencing operations. Pilot oil losses through normal clearance flows are low. In some critical installations pilot pistons are provided with seals and a diaphragm type pilot is virtually "dead end" service.

Second type of bypass valves are the pilot controlled variety shown in Fig. 15. The main spool is normally closed with a relatively soft spring. Operation of the valve results from fluid pressure plus spring force. A chamber of trapped oil is created in the same general area as the main spool spring. Usually, oil under pressure, is allowed to enter this control chamber from the input of the valve through a fixed orifice. At the set value of the integral pilot relief mechanism the pilot oil is allowed to escape back to the reservoir at a larger flow rate than that at which it enters the control chamber. The amount of pressure created by this integral pilot relief valve is added to the initial spring tension against the main spool of the valve. The total of the two is the system pressure ahead of the bypass valve. This means that as an internally controlled unit it operates in the same manner as a pilot type relief valve. As an externally piloted unit a small piston is included to upset the integral pilot control relief valve so that the main spool can rise at the pressure created by the main spool spring.

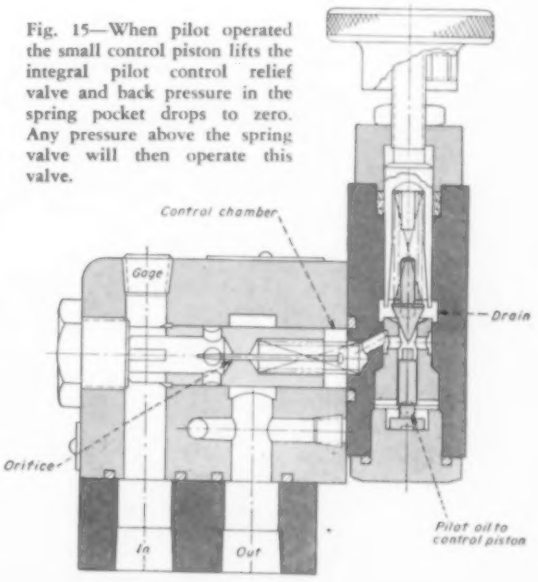


Fig. 15—When pilot operated the small control piston lifts the integral pilot control relief valve and back pressure in the spring pocket drops to zero. Any pressure above the spring valve will then operate this valve.

Electrical Terminal Connections

SOLDERED CONNECTIONS

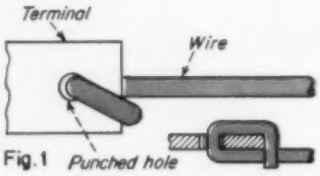


Fig. 1—Punched hole. Stripped end of wire inserted into hole and bent around terminal before soldering.

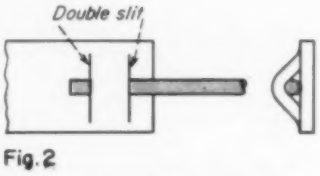


Fig. 2—Double slit stamped by die to form channel for wire. Channel then pressed after wire is inserted.

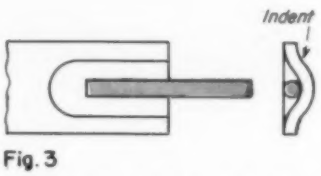


Fig. 3—Indented rib gives good contact area for soldering.

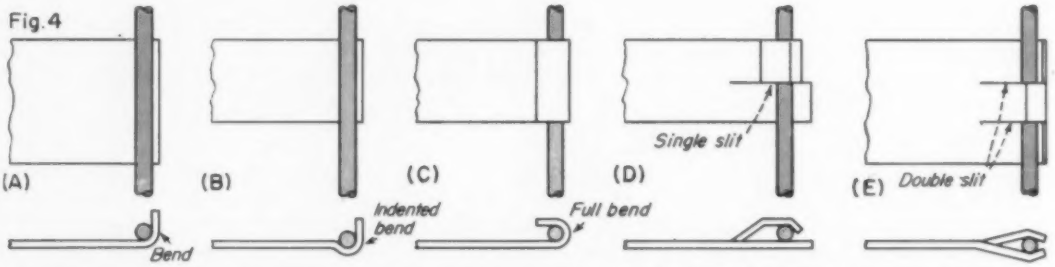


Fig. 4—Right-angle connection between wire and terminal. (A) simple bend, (B) indented bend for greater contact area, (C) full bend for maximum contact area, (D) single slit for firm grip before soldering, (E) double slit for balanced grip.

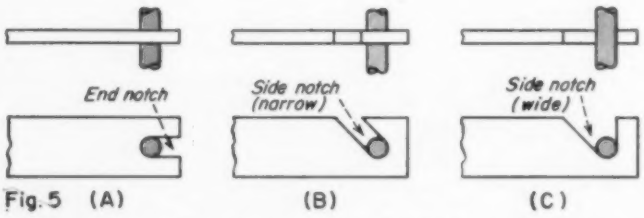


Fig. 5—Connection at right-angle to terminal surface. (A) End notched, (B) side notched to resist end thrust, (C) modified side notch to avoid sharp edge when stamped.

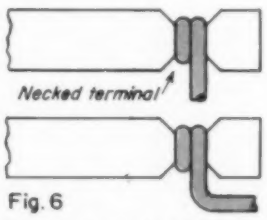


Fig. 6—Necked terminal permits wire to be wrapped before soldering for greater strength.

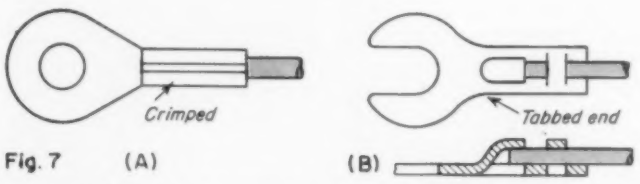


Fig. 7—Shaped terminals. (A) crimped around wire, (B) tabbed and then pressed after wire is inserted. Solder not needed in (A) but should be applied in (B) for maximum efficiency.

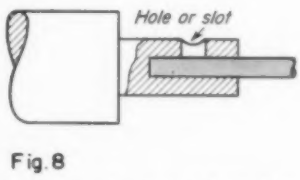


Fig. 8—Axial connection to a rod or shaft can be made by drilling two holes; one for wire, second to permit solder flow.

29 methods of fastening wire to terminals. Soldered connections are usually considered permanent. Screwed connections can be assembled and disassembled without special tools.

SCREWED CONNECTIONS

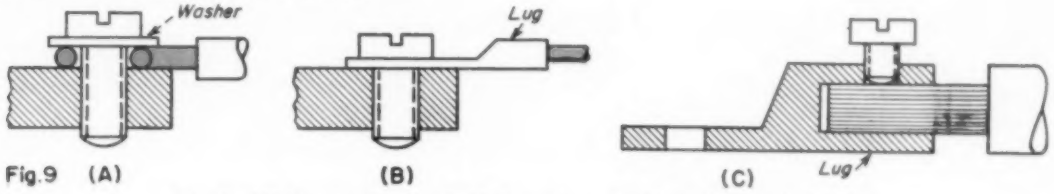


Fig. 9—(A) Screw and washer holds bent wire. (B) No washer required if lug is used. (C) Lug should be screwed if connection is too large for soldering.

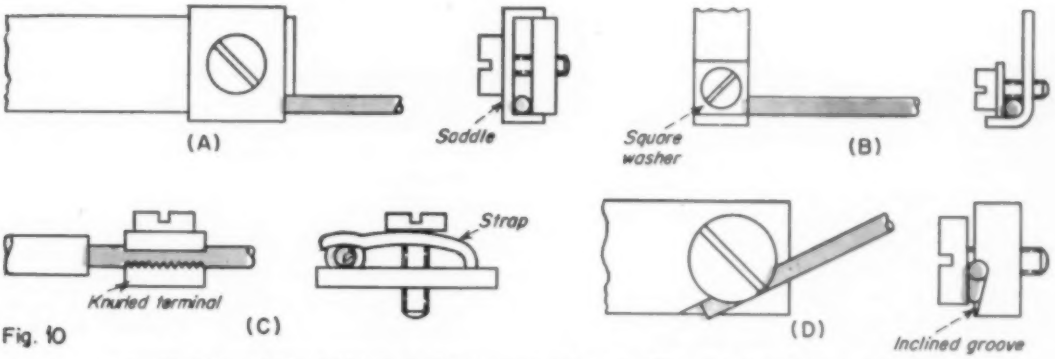


Fig. 10—Clamped wire held between (A) terminal and saddle, (B) terminal and square washer, (C) strap and knurled terminal for better grip, (D) nut and inclined groove cut in terminal.

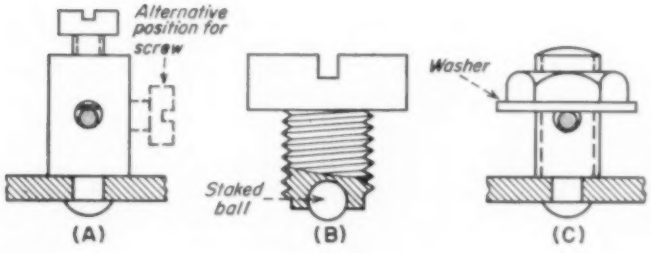


Fig. 11—Terminal posts allow quick and easy connections to be made. Screw has alternate position (A). Special screw (B) has ball staked in end to reduce turning force on wire. Pressure of nuts acts through washer (C). Side slot (D) allows for conditions where axial movement of wire is not possible. Pressure acts through round or square bar (E). Buttress threads (F) prevent terminal opening up.

Fig 11

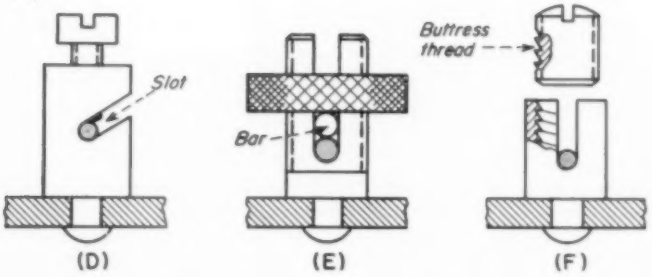
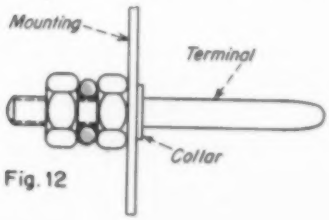


Fig. 12—Wire clamped between two nuts is usual method of connecting leads to male receptacle terminals.



Speed-Torque Analysis

For Rotating Mechanical Systems

Systematic method for deriving and solving equations for speed and torque in an "ideal" rotating system. A succeeding article will extend the method to include the effects of inertia, compliance and friction.

V. H. SELIGER
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DESIGN OF ANY MECHANICAL SYSTEM composed entirely of rotating elements, whether simple or complex, invariably requires at least an approximate determination of the angular velocity and torque at each point of the system. Many such systems function essentially as transmitters of energy; that is, the energy which they transmit from input to output is high compared with that which they store, dissipate, or generate. In such systems, the velocity and torque determinations can often be made with sufficient accuracy by analysis of a related "ideal" system; that is, a system identical with the physical system in question except for the omission of internal energy sources, sinks, and storage elements.

As a simple example, a gear ratio of n to 1 is characterized as follows: output speed is n times the input speed; input torque is n times the output torque. This approximation ignores friction losses in gear mesh, inertia in gears and shafts, shaft compliance, as well as other energy storage and dissipation elements present in the physical system. Nevertheless, this simple characterization expresses the most salient torque and speed relationships of the gear ratio with sufficient accuracy for many purposes, particularly in the initial stages of design.

In more complicated systems, comprising sizeable numbers of interconnected rotating components, the approximate speed and torque relationships of the related "ideal" system are of equal value. However, considerable difficulty is often experienced in the apparently simple job of writing and solving the equations required to determine these quantities. Much of this difficulty, incidentally, arises in connection with the proper assignment of algebraic signs to the quantities involved.

Therefore, a systematic procedure is presented below for writing and solving the angular-velocity and torque equations for "ideal" mechanical systems of rotating components, regardless of their complexity. The procedure is performed in six steps as follows:

1. **Divide the system into parts, so that each part contains one and only one "element."** An "element" refers to a sub-system, the torque and speed relationships of which are known. Typical elements are shafts, gear ratios, mechanical differentials, and other components which constitute the building blocks of the overall system. Schematically, the division into parts can be made by means of "cuts" such as shown in Fig. 1.

2. **Arbitrarily assign a direction of positive motion to each terminal of each device.** The term "terminal" includes both the input and output connections of each device since input and output functions have a way of becoming reversed in complex systems. The assignment must be made unambiguously, in terms of the geometry of the physical element; a mere arrow on a line-schematic diagram will not suffice. A typical assignment at the spider of a differential would be: "Motion of the spider is in the positive direction when the spider rotates counterclockwise, viewed from the end closest to the 46 tooth end-gear." When the positive motion direction has been specified at every terminal of a device, confusion of sign when writing the speed and torque equations for that device is unlikely.

Direction of positive motion assigned to each terminal is taken to be the direction of both positive velocity and positive applied torque at that terminal. Only *applied* torques are considered for clarity although these can, of course, be either positive or negative.

3. **Write the angular velocity equations for each device.** The algebraic signs appearing in the equations are not arbitrary since they have been determined by the geometry of the device and the assignments made in Step 2.

4. **Write the torque equations for each device.** Whereas the velocity relationships for each device are usually obvious from geometry, recourse is often made to the principle of conservation of energy in determining the torque relationships. This principle, in accordance with the definitions of positive velocity and applied torque of Step 2,

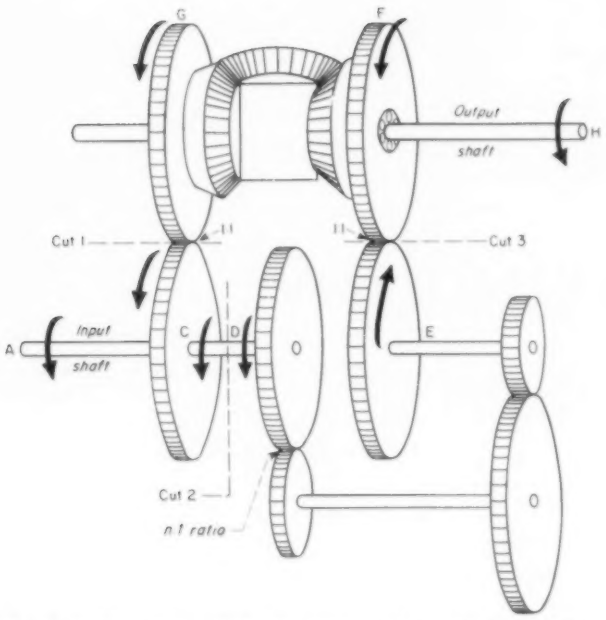


Fig. 1—Typical rotating mechanical system to be analyzed for speed-torque characteristics. System is divided into elements grouped by "cuts" 1, 2, and 3.

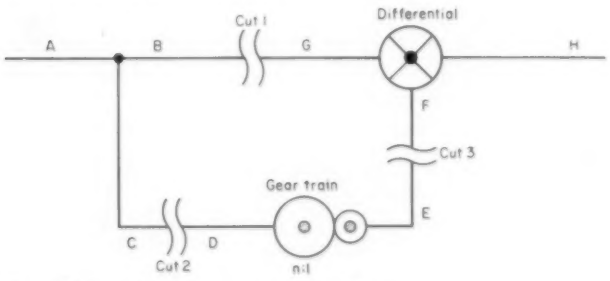


Fig. 2—Schematic of system shown in Fig. 1.

states that the sum of the velocity-torque products at the terminals of each device is zero. Symbolically;

$$\sum_{i=1}^{N} T_i \cdot \omega_i = 0 \tag{1}$$

where

T_i = applied torque at i'th terminal of the device
ω_i = angular velocity at i'th terminal of the device,
N = number of terminals in the device.

5. **Write for each junction of two terminals, or "cut", one of the following pairs of equations:**

$$\omega_L = \omega_R$$
$$T_L = -T_R \tag{2}$$

or

$$\omega_L = -\omega_R$$
$$T_L = T_R \tag{3}$$

where ω_L and T_L are the velocity and applied torque, respectively, of the terminal to the left of the "cut," and ω_R and T_R are to the right. Eqs (2) and (3) are a simple consequence of the law of conservation of energy, applied so a junction ($T_L\omega_L + T_R\omega_R = 0$). Naturally, subscripts already assigned in Steps 4 and 5 are used in place of subscripts L and R.

Choice of Eqs (2) or (3) at each junction is not arbitrary but dependent on the geometry of the connection in the system. For example, consider two elements M and N connected by a shaft S. A cut is made anywhere along the shaft, in Step 1. The left half of the shaft connected to M is considered to be a terminal x of M, and the right half connected to N to the terminal y of N. Assume that, in Step 2, motion at x is positive when it is clockwise, looking along S towards M; and motion at y is positive when it is counterclockwise, looking along S towards N. Then, obviously, positive motion occurs at x and y simultaneously. Thus, $\omega_x = \omega_y$ and hence Eqs (2) must be chosen:

$$\omega_x = \omega_y$$
$$T_x = -T_y$$

On the other hand, had positive motion at x been assumed as before, but motion at y assumed positive when clockwise (looking along S towards N), then positive motion of x would correspond to negative motion of y, and Eqs (3) would be used:

$$\omega_x = -\omega_y$$
$$T_x = T_y$$

6. **Solve equations of Steps 3, 4, 5 for the unknown variables** (ω and T) **at every point** provided a sufficient number of points are specified to yield a determinate solution. In order to simplify the solution procedure, eliminate the variable on one side of each of the junction equations by substitution of the other side wherever the first side appears in the equations of Steps 3 and 4.

Sample Calculations

Given a differential gear system shown in Fig. 1. An input velocity ω_A applied at input shaft A must drive a torque T_H at the output shaft H. If $\omega_A = 2000$ rpm, $T_H = 10$ in.-oz, and $n = 2.5$, find the corresponding torques and angular velocities at various points throughout the system.

Step 1: Group the system by "cuts," as shown by wavy lines in Fig. 2. There are three elements: the differential, gear train and "tee" shaft connection.

Step 2: Positive directions shown in Fig. 1 were assigned as follows:

(a) Differential: Clockwise at G when looking towards center of differential; counterclockwise at F and H when looking towards center of differential.

(b) Gear train: Clockwise at D when looking away from C; clockwise at E when looking towards C.

(c) Tee shaft connection (includes a gear which is not shown in Fig. 1 (B) because it merely represents a one-to-one connection to the differential):

Clockwise at *A*, *B*, and *C* when looking towards *D*.

Other combinations could have been assumed. Note that while arrows have meaning in pictorial illustrations such as Fig. 1, they would be quite meaningless in Fig. 2, which is a line schematic.

Step 3: (a) Differential

$$(\omega_G + \omega_F)/2 = \omega_H \tag{4}$$

(b) Gear Ratio

$$\omega_E = -|n|\omega_D \tag{5}$$

(c) Tee connection

$$\omega_A = \omega_B = \omega_C \tag{6}$$

Step 4: (a) Differential, by symmetry

$$T_G = T_F \tag{7}$$

$$\text{also} \quad T_G\omega_G + T_F\omega_F + T_H\omega_H = 0 \tag{8}$$

From Eqs (4), (7) and (8):

$$T_G(\omega_G + \omega_F) + \tfrac{1}{2}T_H(\omega_G + \omega_F) = 0 \tag{9}$$

$$\text{or} \quad T_G = -\tfrac{1}{2}T_H \tag{10}$$

(b) Gear Ratio

$$T_D\omega_D + T_E\omega_E = 0 \tag{11}$$

From Eqs (5) and (11):

$$T_D\omega_D - T_E|n|\omega_D = 0 \tag{12}$$

$$\text{or} \quad T_D = |n|T_E \tag{13}$$

(c) Tee connection

$$T_A\omega_A + T_B\omega_B + T_C\omega_C = 0 \tag{14}$$

From Eqs (6) and (14)

$$T_A + T_B + T_C = 0 \tag{15}$$

Step 5: (a) Junction B-G (cut 1):

$$\omega_B = -\omega_G \tag{16}$$

$$T_B = T_G \tag{17}$$

(b) Junction C-D (cut 2.:

$$\omega_C = \omega_D \tag{18}$$

$$T_C = -T_D \tag{19}$$

(c) Junction E-F (cut 3):

$$\omega_E = \omega_F \tag{20}$$

$$T_E = -T_F \tag{21}$$

Step 6: Eliminate ω_B, T_B, ω_C, T_C, ω_E and T_E wherever appearing in Eqs (4) to (15) by use of Eqs (16) to (21):

$$\omega_F = -|n|\omega_D \tag{22}$$

From Eq (6):

$$\omega_A = -\omega_G = \omega_D \tag{23}$$

From Eq (13):

$$T_D = -|n|T_F \tag{24}$$

From Eq (15):

$$T_A + T_G - T_D = 0 \tag{25}$$

From Eqs (4) and (22):

$$\omega_G - |n|\omega_D = 2\omega_H \tag{26}$$

From Eqs (23) and (26):

$$\omega_G + |n|\omega_G = 2\omega_H \tag{27}$$

$$\text{or} \quad \omega_H = \tfrac{1}{2}\omega_G(1 + |n|) \tag{27}$$

From Eqs (23) and (27):

$$\omega_H = -\tfrac{1}{2}\omega_A(1 + |n|) \tag{28}$$

Now that the output speed equation has been established for the system, numerical values for all the elements are obtained as follows:

$$\omega_A = \omega_B = \omega_C = \omega_D = 2000 \text{ rpm}$$
$$\omega_G = -\omega_A = -2000 \text{ rpm}$$
$$\omega_E = \omega_F = -|n|\omega_D = -|n|\omega_A = -5000 \text{ rpm}$$
$$\omega_H = -\tfrac{1}{2}(2000)(1 + 2.5) = -3500 \text{ rpm}$$

From Eqs (7), (24) and (25):

$$T_A + T_G + |n|T_G = 0$$

$$\text{or} \quad T_A = -T_G(1 + |n|) \tag{29}$$

From Eqs (10) and (29):

$$T_A = \tfrac{1}{2}T_H(1 + |n|)$$
$$= \tfrac{1}{2}(10)(3.5) = 17.5 \text{ in.-oz}$$

Other torque values can now be determined by inspection of the equations.

$$T_B = T_G = -\tfrac{1}{2}T_H = -5 \text{ in.-oz}$$
$$T_C = -(T_A + T_B) = -(17.5 - 5) = -12.5 \text{ in.-oz}$$
$$T_D = -T_C = +12.5 \text{ in.-oz}$$
$$T_E = T_D/|n| = 12.5/2.5 = 5 \text{ in.-oz}$$
$$T_F = T_G = -5 \text{ in.-oz}$$

Negative signs indicate that the corresponding angular velocities or torques are in direction opposite to those shown by the arrows.

As a final check the above values can be substituted in the overall system speed-torque equation, which from Eq (1) is

$$T_A\omega_A + T_H\omega_H = 0$$
$$(17.5)(2000) + (10)(-3500) = 0$$

The method presented above is applicable to ideal mechanical systems of rotating components which neither store, generate nor dissipate energy. A subsequent article will extend the above method to include the effects of inertia, compliance and friction.

Wanted—Inventions

Despite the fact that the government's military laboratories are carrying on extensive research and development programs, there is always a need for new ideas and techniques which might help the military in their efforts to make superior weapons and equipment. The National Inventors Council of which Charles F. Kettering is Chairman periodically lists the technical problems affecting National Defense. Not all are strictly problems, but areas in which further technological advances are desirable. A few are listed here. A complete list may be obtained from the National Inventors Council, U. S. Dept. of Commerce, Washington, D. C.

A device to slow down the rate of descent of small projectiles, such as a 155 mm shell, to reduce landing impact to a few hundred G's; methods for combating radar jamming devices; three-dimensional radar coverage; portable, ground-based equipment for meteorological surveys up to 100,000 ft or higher without using airborne instruments; a cooling device (other than fans, blowers, etc.) for small electronic devices; a potting material for use with transistors; a low temperature alkaline-zinc-mercuric oxide battery system.

ULICK R. EVANS
VERA E. RANCE

Corrosion of Dissimilar Metals

Relative corrosion of dissimilar metals in contact; effect of electrolyte, metallic coatings and other causes on degree of attack; preventive methods and their efficiency.

WHEN TWO DIFFERENT METALS ARE IN CONTACT and are also bridged by water containing an electrolyte current flows through the electrolyte from the anodic metal to the cathodic metal. As a result of the ensuing electrolytic action, the cathodic metal tends to be protected but the anodic metal may suffer greater corrosion than when it is connected to a metal similar to itself. The change in corrosion rate of the anodic metal is shown in the accompanying table.

The table is not to be regarded as infallible. The information it contains is largely qualitative: moreover, knowledge and experience of certain combinations is very inadequate and, in any case, it is impossible concisely to tabulate the effects of a wide variety of exposure conditions.

Method of Tabulation. The groups of metals numbered 1 to 10 are arranged as a sequence which is approximately similar to the table of potentials against the saturated calomel electrode in sea water at room temperature. The groups of metals 11 to 16 are not arranged in any particular sequence. Chromium, stainless steel, titanium and aluminum develop highly protective oxide films and behave as relatively noble metals under conditions favorable to the maintenance of such films, but are in some cases less resistant under conditions in which breakdown of the films is possible. It is these metals in particular which cause difficulty in attempting to predict the behavior of dissimilar metals in contact from a table of potentials.

The symbols in the table record only the acceleration of corrosion resulting from the dissimilarity of the metals in contact: no information is given on the basic corrosion resistance inherent in the particular metal. The degree of acceleration is classified A, B, C and D in increasing intensity as defined in the Table. The symbol given for each combination of groups is based on direct experience and on general electrochemistry. This applies particularly to groups 11 and 16. Where two symbols are given (as B or C) the acceleration is particularly liable to change with variations in the environmental conditions or the condition of the metal.

The Electrolyte and its Effect. From a practical point of view, moisture from any source, such as condensation, rain or sea-water, often contains an electrolyte such as salt or acid. Contact of dissimilar metals affects corrosion only while a continuous film or body of water joins the different metals so that the small electric current which forms an essential part of the corrosion process can pass through this water, the circuit being completed by the metallic contact. The severity of the effect in a given time is dependent on the conductivity of the water, which is itself dependent on the quantity and nature of the electrolyte dissolved in it. If contact through the water is intermittent, the effect is dependent on the total time of contact.

Effects are most severe when the metals are immersed in water, spreading for considerable distances from the line of contact, although diminishing in intensity as the distance from that line increases. In atmospheric conditions the effect is usually much more localized to the vicinity of the line of contact. A film of moisture condensed from the air will dissolve electrolyte from polluted atmosphere and can then cause appreciable acceleration of corrosion.

If the water contains certain substances which form complex ions, such as cyanides, citrates and tartrates, the data given may be incorrect, since the effect of these complex ions has not been taken into account in computing the table. Thus, if one of these reagents forms complex ions containing a given metal, that metal will behave less nobly than the symbol in the table would indicate. The most common reagent of this type is ammonia, which has no action on iron but attacks copper (normally a more noble metal) in the presence of air.

One source of trouble is the use of certain fluxes at soldered joints which leave hygroscopic residues and produce moist conditions at the joint. This may be avoided by thorough cleaning after soldering or, preferably, by the use of suitable non-corrosive fluxes.

Serious acceleration of corrosion can occur when the two metals concerned are not directly joined together.

Condition of the Metal. The different alloys within one of the groups in the Table may differ significantly

TABLE I—CORROSION INCREASE BY CONTACT OF DISSIMILAR METALS

CODE

A–The corrosion of the "metal considered" is not increased by the "contact metal".

B–The corrosion of the "metal considered" may be slightly increased by the "contact metal".

C–The corrosion of the "metal considered" may be markedly increased by the "contact metal" (Acceleration is likely to occur only when the metal becomes wet by moisture containing an electrolyte such as salt, acid, combustion products. In ships, acceleration may be expected to occur under inboard conditions, since salinity and condensation are frequently present. Under less severe conditions the acceleration may be slight.

D–When moisture is present, this combination is inadvisable, even in mild conditions, without adequate protective measures.

METAL CONSIDERED ↓ / CONTACT METAL →		Gold, platinum, rhodium, silver	Monel, Inconel, nickel molybdenum alloys	Cupronickels, silver solder, aluminum bronzes, tin bronzes, gunmetals
1. Gold, platinum, rhodium, silver		—	A	A
2. Monel, Inconel, nickel-molybdenum alloys		B	—	A
3. Cupronickels, silver solder, aluminum bronzes, tin bronzes, gunmetals		C(k)	B	—
4. Copper, brasses, nickel silvers		C(k)	B or C	B or C(g)
5. Nickel		C	B	A
6. Lead, tin and soft solders		C	B or C(t)	B or C(q)
7. Steel and cast iron (a) (f)		C	C	C
8. Cadmium		C	C	C
9. Zinc		C	C	C
10. Magnesium and magnesium alloys (chromated) (b) (a)		D	D	D
11.	Austenitic 18/8	A	A	A
12. Stainless steel	18/2 Cr/Ni	C	A or C(s)	A or C(s)
13.	13% Cr	C	C	C
14. Chromium		A	A	A
15. Titanium		A	A	A
16. Aluminum and aluminum alloys (n) (a)		D	C	D(e)

(a) The exposure of iron, steel, magnesium alloys and unclad aluminum-copper alloys in an unprotected condition in corrosive environments should be avoided wherever possible.

(b) Except when used for affording cathodic protection, magnesium and magnesium alloys should not normally be used in an unchromated condition unless otherwise protected. When a volume of water (as opposed to a film of atmospheric moisture) can collect at a junction, they should, even when chromated, be insulated from more noble metals. Steel, brass and copper parts such as nuts, bolts, washers, screws and studs, should be galvanized, cadmium plated or otherwise protected. If, however, jointing compound is employed, insulation may sometimes be unnecessary but advice should be sought from a corrosion specialist.

(c) Where contact between magnesium and aluminum alloys is necessary, the use of aluminum alloys with low or negligible copper content is preferred.

(d) If in contact with thin (decorative) chromium plate, the symbol is C, but with thick plating (as used for wear resistance) the symbol is B.

(e) Where contacts between copper or copper-rich materials and aluminum alloys cannot be avoided, a much higher degree of protection against corrosion is obtained by first plating the copper-rich material with tin or nickel and then with cadmium, than by applying a coating of cadmium of similar thickness. The aluminum in contact with the copper-rich material should be anodized when practicable.

(f) The corrosion of mild steel may sometimes be increased by coupling with cast iron, especially when the exposed area of the mild steel is small compared with the cast iron.

(g) Instances may arise in which corrosion of copper or brasses may be accelerated by contact with bronzes or gunmetals, as when the corrosion of copper, seawater-carrying pipe-lines may be accelerated by contact with gunmetal valves, etc.

(h) When magnesium corrodes in sea-water or certain other

in composition and may, therefore, act like dissimilar metals when in contact with each other: for example, in group 4, the corrosion of one brass can be accelerated by contact with another brass. These effects within the groups have been disregarded in order to minimize the number of groups and to keep the table as simple as possible. Moreover, the behavior of a given alloy in contact with another metal is affected by its condition. For example, with some aluminum-copper alloys, the naturally aged alloy is more noble than the artificially aged alloy. Again these effects are disregarded to avoid undue complication of the table.

The more noble character of the stainless steels is dependent upon the protective film on the metal, and the maintenance of this film is, in turn, dependent upon the continuous presence of oxygen.

Metallic Coatings. Metals like chromium, nickel, cadmium and zinc in the table are most commonly used as protective coatings on another metal. The electrochemical behavior of a metallic coating is generally similar to that of the same metal in the massive state, provided that it is reasonably thick and free from pores; reference should be made to the appropriate group in the table. Where discontinuities exist in a coating, a corrosion cell may be set up which can cause attack on the basis metal (if the coating is the more noble) or undue wastage of the coating metal (if coating is less noble than the basis metal.) For this reason, **drilling and**

Copper, brasses nickel silvers	Nickel	Lead, tin and soft solders	Steel and cast iron	Cadmium	Zinc	Magnesium and magnesium alloys (chromated)	Stainless Steels			Chromium	Titanium	Aluminum and aluminum alloys
							Austenic 18 Cr-8 Ni	18 Cr-2 Ni	13 Cr			
A	A	A	A	A	A	A	A	A	A	A	A	A
A	A	A	A	A	A	A	A	A	A	B	B	A
A	A	A	A	A	A	A	B or C	B	A	B or C	C	A(e)
——	B or C	B or C(p)	A	A	A	A	B or C	B or C	A	B or C	C	A(e)
A	——	A	A	A	A	A	B or C	B or C	A	B or C	C	A
B or C(q)	B	——	A or C(r)	A	A or C(r)	A	B or C	B or C	B or C	B or C	C	A
C	C(k)	C(k)	——	A(m)	A(m) (1)	A	C	C	C	C(k)	C	B(m)
C	C	B	C	——	A	A	C	C	C	C	C	B
C	C	B	C	B	——	A	C	C	C	C	C	C(j)
C	D	C	C	B or C	B or C	——	C	C	C	C	C	B or C(c)
A	A	A	A	A	A	A	——	A	A	A	A	A
A or C(s)	A	A	A	A	A	A	A	——	A	A	(o)	A
C	B or C	A	A	A	A	A	C	C	——	C	C	A
A	A	A	A	A	A	A	A	A	A	——	A	A
A	A	A	A	A	A	A	A	A	A	A	——	A
D(e)	C(k)	B or C	B or C	A	A	A(c) (h)	B or C	B or C	B or C	B or C(d)	C	——

electrolytes, alkali formed at the aluminum cathode may attack the aluminum.

(j) When it is not practicable to use other more suitable methods of protection such as spraying with aluminum, zinc may be useful for the protection of steel in contact with aluminum, despite the accelerated attack upon the coating.

(k) This statement should not necessarily discourage the use of the "contact metal" as a coating for the "metal considered", provided that continuity is good; under abrasive conditions, however, even a good coating may become discontinuous.

l) In most supply waters at temperatures above about 140 F, zinc may accelerate the corrosion of steel.

(m) In these cases the "contact metal" may provide an excellent protective coating for the "metal considered", the latter usually being electrochemically protected at gaps in the coating.

(n) When aluminum is alloyed with appreciable amounts of copper it becomes more noble and when alloyed with appreciable amounts of zinc it becomes less noble. These remarks apply to contacts and not to the inherent corrosion resistance of the individual aluminum alloy. Such effects are mainly of interest when the aluminum alloys are connected with each other.

(o) No data available.

(p) In some immersed conditions, the corrosion of copper or brass may be seriously accelerated at pores or defects in tin coatings.

(q) In some immersed conditions there may be serious acceleration of the corrosion of soldered seams in copper or copper alloys.

(r) When exposed to the atmosphere in contact with steel or galvanized steel, lead can be rapidly corroded with formation of PbO at narrow crevices where access of air is restricted.

(s) Serious acceleration of corrosion of 18/2 stainless steel in contact with copper or nickel alloys may occur at crevices where the oxygen supply is low.

(t) Normally the corrosion of lead tin soldered seams is not significantly increased by their contact with the nickel-base alloys.

shearing should precede electroplating or other coating processes rather than follow them, and precautions should be taken against wear or other mechanical damage to the coating.

Contact of metallic coating with a more noble metal may accelerate wastage of the coating so as to cause exposure of the basis metal which may then accelerate corrosion of the second metal.

Area Relationships. The danger of corrosion at the junction of two dissimilar metals is greatest if the area of the nobler metal or cathode is large compared with the area of the less noble metal or anode. The danger of very intense attack, when the ratio of the cathodic to anodic areas is high, is greatest under immersed–as opposed to atmospheric–conditions. Aluminum alloy bolts used to join copper alloy plates would be likely to suffer rapid corrosion; aluminum alloy plates joined with copper alloy bolts would probably suffer less intense attack. Neither arrangement, however, represents good practice. When the life of a structure or the functioning of a mechanism may be more seriously affected by the corrosion of one component than another, the more vulnerable component should preferably be cathodic to any less vulnerable part with which it makes contact.

Microgalvanic Effects. In certain metallic pairs, accelerated corrosion of the baser member can occur even when there in no metallic contact between the dissimilar metals. For example, in a system conveying water,

small amounts of copper, dissolved by the water from copper or copper alloy components, may be deposited on less noble metals in the system such as zinc, aluminum or ferrous alloys, with which the water may subsequently come into contact. The microscopic couples so formed are liable to result in severe pitting of the base metal.

Effects of Graphite, Coke or a Carbonaceous Film. Left on metal after fabrication, these may act as a noble electrode in a couple and accelerate corrosion. Graphite in packing has also caused trouble and has been replaced, in some cases, by mica.

Other Contact Effects. In some circumstances the corrosion of a metal can be accelerated by contact with an identical metal, a metal of the same group of the table, or a non-metallic material. When a metal is joined to another material in such a way as to form a crevice, corrosion may be accelerated in the crevice. Corrosion at crevices where there is poor oxygen replenishment is particularly dangerous for stainless steels and certain aluminum alloys. A deposit on a metal may cause attack under the deposit due to differential aeration of interference with the formation of a protective film on the metal. Corrosion at two metal surfaces in contact may be accelerated when there is slight repeated relative movement between them, giving rise to "fretting" corrosion.

Certain timbers and phenolic materials, including some varnishes and organic insulating materials, may give off corrosive agents which are frequently volatile; such materials may cause corrosion not only of metal components with which they are in contact, but of other metals in the same enclosed space.

Prevention of Corrosion. The most effective methods of prevention lie in careful design and assembly and assembly practices. Avoid dangerous contacts where possible; avoid water-collecting pockets around unavoidable contacts; build in adequate ventilation and drain holes; provide for the protective measures suggested below and see that they are applied during assembly. When protection is achieved by painting and it is impractical to paint both metals, then it is preferable to paint the more noble metal.

Insulation. This is the fundamental method of preventing corrosion currents. It may be achieved by two methods: effectively insulating the dissimiliar metals from each other, thus breaking the metallic circuit; or preventing a continuous bridge of water between the two metals, thus breaking the electrolytic path. In immersed conditions, the second method is not possible, but the first may be used if insulation is not precluded by the need for electrical bonding for functional purposes. For example, a base metal nut and bolt should be fitted with an insulating bushing and washers where it passes through a nobler metal plate. Complete insulation is here essential and hence the bushing is vital. In atmospheric conditions, a large insulating washer may suffice to break the water film or to reduce the total corrosive action or to render it insignificant by distributing it over a wide area, and in this case the bushing may not be necessary. All insulating materials should be impervious to water.

Metallic Coatings. Dissimilarity may be avoided by coating one metal (preferably the cathode) with the other metal or one compatible with it. Coating may be by electrodeposition, hot dipping or metal spraying. In airframe assemblies all bolts, screws, pins or bushings made from stainless steels and other steels should be cadmium plated whenever such parts are used in contact with light alloys. Alternatively, similar or compatible metallic coatings may be applied to both the noble and base metals. These precautions are effective only while the coating remains intact (especially when only the anodic metal is coated) so that for long service, preservation of the coating by passivation or painting may be required.

Jointing Compounds. If adequately pigmented with corrosion inhibitor these compounds may suffice for moderate conditions, but subsequent painting is also advisable.

Painting. Painting the assembled joint is effective only for mild conditions and should include a primer (adequately pigmented with an inhibitor such as chromate) followed by a good waterproofing paint. The combination of jointing compounds and painting is better than either alone.

Cathodic Protection. When the corrosion of a base metal is accelerated by contact with a nobler metal the corrosion of the latter is usually decelerated and may be prevented altogether. If a metal less noble than these is effectively introduced into the system it can similarly protect both metals of the assembly. The method is referred to as cathodic protection or sacrificial protection. Care must be taken to make and maintain good contact of sacrificial metal with the protected metal and with the corrosive medium and to make provision for replacement of the sacrificial metal when serious wastage of it has occurred.

Similar results can be achieved by imposition of a current from an external source. Cathodic protection is particularly applicable to immersed corrosion, but can sometimes be applied to atmospheric corrosion; for instance, zinc washers may be useful when steel bolts are used in an aluminum alloy structure.

Non-Metallic Coatings (excluding paint). These are effective in particular cases. Thus, anodizing of aluminum alloys is useful in moderate conditions, or may be used to contribute to the precautions adopted. Chromating by itself is not an adequate protection for magnesium base alloys, and a full protective scheme should be used.

Microgalvanic Effects. The safest methods of preventing microgalvanic effects depend on preventing contamination of the water with the more noble metal, as by protecting the more noble metal by coatings or cathodic protection. The addition of inhibitors to the water is sometimes useful.

EDITOR'S NOTE—The present article has been adapted from a 1956 booklet "Corrosion and Its Prevention at Bimetallic Contacts" prepared by the Corrosion and Electrodeposition Committee of the Inter-Service Metallurgical Research Council (Admiralty and Ministry of Supply). It is now published by permission of the Controller of Her Britannic Majesty's Stationery Office.

Stress-corrosion, corrosion fatigue, impingement, erosion and fretting were treated in an earlier article, "Resistance of Materials to Mechanical Corrosion," January 1956 page 194. "Cavitation in Ultrasonic Equipment," September 1955 page 173, described the use of ultrasonics to induce cavitation near the surface of a number of materials.

TECHNICAL NEWS

THE GERMAN GOLIATH GP 900 E which will be introduced in this country next spring. Using a 40 hp 2-cylinder 2-cycle engine, the car will have fuel injection and will sell for about $1,600. Wheelbase is 90 in.

LOOKING IN OVER THE RADIATOR at the engine mounted transversely over the front axle. Mounted adjacent to the spark plugs are the injection valves, whose lines (see coiled piping left, center) lead from two injection pumps at lower left.

Low Priced German Car Has Fuel Injection

Fuel injection on cars in the real low price field will become a reality next spring when the German Goliath GP 900 E (above) enters the U. S. automobile market selling for $1600. Of particular interest is the fact that the Goliath will have a 2-cylinder, 2-cycle engine, a type of engine not commonly associated with fuel injection systems. Manufacturer of the fuel injection system is the Robert Bosch GmbH of Germany, who also makes the fuel injection used on the 6-cylinder, 4-cycle engine used in the Mercedes-Benz cars.

The Goliath's engine is rated at 40 hp at 4000 rpm with a top speed of 75 mph. Maximum torque is 7.5 m-kg at 2750 rpm. Cylinder displacement is 43-cu in. The car has a 4-gear, hand shift, transmission, and front wheel drive, which is reported to guarantee higher driving safety with a greater directional stability on the straightaway and the curves. Gear ratios are: (1) 4.00; (2) 2.33; (3) 1.40; (4) 0.875; reverse 3.82.

Acceleration, with two passengers, is from 0 to 62 mph in 35 sec. Climbing performances with full load is: 1st gear, 28 per cent; 2nd, 18 per cent; 3rd, 9 per cent; 4th, 4 per cent. Fuel consumption at 50 mph is about 40 miles per gallon. Oil added to the fuel is in a ratio of 1:40, compared to the 1:25 ratio of a carburetor type 2-cycle engine. In relation to road distance, more oil is used than on a

4-cycle engine, but no engine oil changes are necessary. Also, the fuel and oil are filled separately; thus it is not necessary to figure out how much oil should be added to a certain amount of fuel.

Both Bosch injection systems (Mercedes-Benz, 4-cycle, and the Goliath, 2-cycle) use the same injection and control principles as the aircraft injections which Bosch produced. An individual pumping unit is used for each cylinder. Mixture control is obtained by a control unit which uses manifold vacuum, acting on a diaphragm connected to the injection pump rack, thus adjusting the quantity of air taken by the engine. The fuel quantity per stroke varies with manifold pressure.

Bosch produces systems for cylinder injection only. This is the only feasible method for 2-cycle engines. However, with 4-cycle engines, port injection (through open intake valves) is a possibility, and Bosch is developing a pump for this purpose.

Vickers Has New Power Steering Pump

Vickers, Inc., of Detroit, Mich., has come up with a new pump design to be used for power-steering on the 1957 Dodge and DeSoto passenger cars. Called the VT27, it differs principally from the earlier model (VT24) in that the new pump is a block-mounted, pulley-driven pump as against a generator-mounted, shaft-driven pump.

Major differences between this pump and the older model are: 1957 model pump has a drive shaft about ¾ in. longer and a ball bearing used in the 1956 model has been eliminated completely. In place of the ball bearing a steel-backed bronze bearing is used to support the shaft, and the shaft is longer for this reason.

The cam-contour ring, formerly a large casting of expensive high-alloy steel, has been reduced in size, and the pump cover has been modified to fill the area once occupied by the cam contour ring. Vickers reports a considerable savings in metal and money. Compared to the 1956 model, operating pressure will be up from 400 to 700 psi; and rpm down from 600 to 510 rpm.

X-Ray Microscope to Aid Metallurgical Research

Corrosion, the effect of foreign materials, soundness of electroplated coatings, and the effects of various processes on the behavior and structure of metals may now be further explored with the aid of a new X-ray microscope developed by General Electric Co., Schenectady, N. Y.

The secret of the X-ray microscope lies in the small size of the focal spot, which is bombarded by electrons and thus caused to give off X-rays. This target is only 40 millionths of an inch in diameter. X-rays emanating from such a small spot fan out in all directions and hence magnify any object which they pass through. The X-ray microscope achieves magnifications up to 1500 times, and at the same time discloses the inner structure of the object being examined.

Basically, a narrow beam of electrons emerges from an electron gun This beam is cut down to desired size by a condenser lens, and then passes through an objective lens. The tiny beam then bombards the target made of a sheet of tungsten which is thick enough to stop the electrons but thin enough to permit the generated X-rays to pass through. The remainder of the instrument is a simple shadow projection microscope. That is, a specimen placed near the X-ray source casts an enlarged image on a flourescent screen, where it can be viewed by the eye, or on a photographic film where the image is recorded.

While not as powerful in its magnifying power as the electron microscope, the X-ray microscope has an advantage in that it does not require mounting the specimen in a vacuum and other special preparation techniques. Its advantage over the optical microscope is in the depth of focus which allows three-dimensional examination of the specimen. No special sectioning is required. Its inherent advantage over both is that it penetrates to the interior of the object and reveals structures otherwise not visible.

A POLAROID CAMERA is shown photographically recording an object magnified with an X-ray microscope. The microscope can achieve magnification up to 1500 times.

Xeroradiography—for Rapid, Industrial X-Rays

Industrial X-ray images can be produced faster and at a lower cost by a "blackboard" radiographic method known as xeroradiography. This new system will find particular acceptance in the field of light alloys and in applications formerly requiring X-rays at voltages up to 300,000 at short exposure times.

Xeroradiography works on the following principle: a selenium-coated metal plate is electrostatically charged before exposure to X-rays. The X-rays, which pass through an assembly or casting, will discharge the plate partially, in inverse proportion to the density of the X-rayed object. The result is a latent electrostatic image on the plate. To make this pattern visible, one inserts the plate in a device which sprays it with powder. This powder adheres to the charged parts of the plate, gathering more closely in the higher charged areas than in the lower charged areas, thus forming a visible image.

Advantages of the new method are: (1) the process is entirely "dry"; no darkroom is required to wet-develop films with chemicals and then dry them; (2) the plates can be "erased" and reused over and over again; (3) the images are detailed, and in many cases as sensitive as conventional film radiography; (4) only from 20 to 45 sec elapse from the time the exposure is completed to the time a plate is ready for viewing.

Developed by the Haloid Co., Rochester, N. Y., and Battelle Memorial Institute, Columbus, Ohio, the process may make possible continuous production-line inspection particularly in the field of light alloys. The equipment needed for xeroradiographic work includes plates with active areas of 9 x 14 in., a sensitizing or charging device, a developing chamber, transferring equipment to obtain a permanent record if desired.

The X-ray equipment used for xeroradiography is the same as for conventional film. In quantity production, the cost of producing a xeroradiographic image on a plate (i.e., processing and plate replacement excluding investment in equipment), is estimated at around 50 per cent less than for film.

THE ONTOS—GREEK FOR "THING"—is the Marine Corps' newest deadly weapon. An extremely mobile tank-type vehicle, the 8½ ton track vehicle was developed by Allis-Chalmers for Army Ordnance, but later was adopted by the Marine Corps as an anti-tank weapon. The Ontos mounts six 106 mm recoilless rifles, four .50 cal spotting rifles, and one .30 cal machine gun. When the spotting rifles find the target, the 106 mm guns automatically are fixed on the target. They can be fired singly, in pairs, or in a six-gun salvo. Carrying a crew of three—driver, gunner and ammunition loader—the Ontos claims more firepower than any other land combat vehicle in history. It relies primarily on the speed with which its big guns can be trained on the target, and its high maneuverability. Maximum speed on an improved road is 30 mph. A 6-cylinder 145 hp gasoline engine is used.

Non-Metallic Permanent Magnet Holds Strength

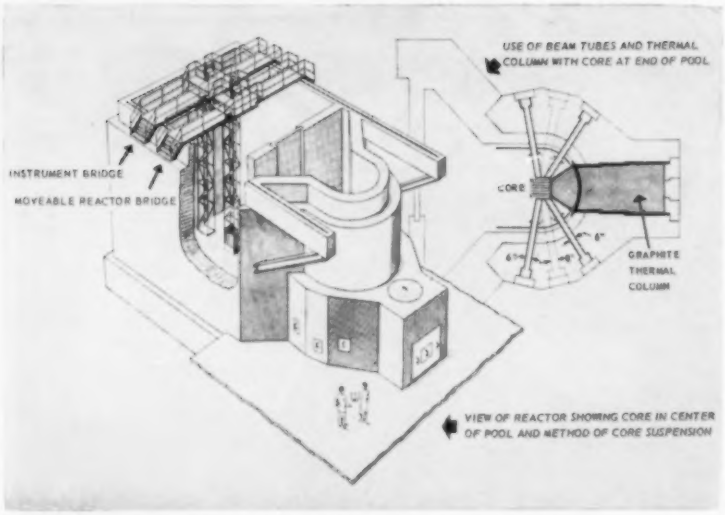
A ceramic material that is non-metallic, electrically non-conductive, and can be permanently magnetized to hold its strength under adverse conditions has been developed by the North American Philips Co., Inc., 100 East 42nd St., New York, N. Y. Called Ferroxdure, its potential applications are refrigerator and cabinet door latches, loudspeakers, television for focusing yokes, motors, generators, oil filters, rotating mechanical couplings, cushioning devices, and toys.

The magnetic ceramic is produced without critical materials such as cobalt or nickel and can be molded into various shapes. Ferroxdure is unaffected by external fields and is said to be almost impossible to demagnetize once it has been polarized. Compared with metal magnets, it is smaller in size, lighter in weight, has longer effective life, and improved performance at lower cost.

Chemical composition of the ceramic is $Ba\ Fe_{12}\ 0_{19}$. It is a brittle sintered ceramic which can be ground, and has an electrical resistivity of more than 10^8 ohm per centimeter. Density (actual) is 4.8 to 4.9 grams/cu-centimeter; density (X-ray) is 5.3 grams/cc. The coercive force varies from 1200 to 2000 oersted.

Photo shows the repelling power of two magnetized Ferroxdure rings.

TECHNICAL NEWS


USE OF BEAM TUBES AND THERMAL COLUMN WITH CORE AT END OF POOL
INSTRUMENT BRIDGE
MOVEABLE REACTOR BRIDGE
CORE
GRAPHITE THERMAL COLUMN
VIEW OF REACTOR SHOWING CORE IN CENTER OF POOL AND METHOD OF CORE SUSPENSION

THE REACTOR'S CORE, suspended in a pool of water by a tower on a movable bridge, consists of 20 fuel elements each 3 in. sq by 2 ft. The second bridge is used to bring materials close enough to the core for experimental irradiation. The reactor core can be moved close to the right end of the pool where special "beam tubes" and a "thermal column" contain specimens to be irradiated.

Battelle Institute Builds A Reactor

The nation's first privately owned nuclear research center has been completed at Battelle Institute's Columbus, Ohio laboratories. Designed by Battelle physicists and built by the American Machine & Foundry Co., the ¾-million dollar reactor will be used exclusively for research purposes.

A two-section, water-filled pool in which the reactor core is suspended is approximately 20 by 40 by 28 ft deep. It is the largest of the "pool" type reactors to be put in service in this country.

The core, composed of fuel elements of uranium-aluminum alloy clad with 25 aluminum and boron control rods is suspended from the movable control bridge, and operates at full power in either of two positions. One position is in the approximate center of the pool, where bulk shielding and other large experiments may be performed. The other position is in a stall at one end of the pool, in front of beam tubes and the graphite thermal column. A second movable bridge, with a support column extending downward to the level of the core face, is used for supporting instruments and specimens adjacent to the core.

Cooling, shielding, and controls are all designed for continuous operation at power up to one megawatt. Two 8 in. and four 6 in. dia beam tubes extending from the outside vertical walls of the pool through to the face of the core are among the locations where specimens or experiments may be placed to utilize neutron or gamma radiation. At one megawatt level of power, the approximate radiation fluxes are 10^{13} n/cm²-sec for fast and thermal neutrons and 5×10^{13} photons/cm²-sec gamma flux. The reactor will permit experiments on all types of materials under different conditions with both neutrons and gamma rays present, and with either type of radiation independent of the other. Experiments can be: static irradiation of solids at room temperature and pressure; irradiation of solid specimens at high temperatures and in a specified medium; and irradiation of fluids in a dynamic system allowing for such conditions as heating and circulation.

For fast irradiation of small specimens, the reactor has a "weasel tube." This operates hydraulically to carry 2 in. dia. parts to the core face with a minimum exposure time of 2 sec.

Briefs

Room temperature curing silicone rubber is being used by Northrop Aircraft, Inc., to protect the high impedance circuits in the Snark guided missile and other Northrop projects. After the electronic panels in the circuits get the necessary resistors, capacitors, transistors, and other equipment, the panels are coated with Silastic RTV. According to Northrop, a single coating of silicone rubber: cushions vibration at low temperature; gives good moisture resistance; improves all the electrical properties of the panel, especially surface resistivity; and protects the assemblies in rough handling. Any inspection of components is simplified because the rubber is slit open, the component checked, and the slit patched with the same room temperature curing rubber. Application is with a Semco gun at 100 psi.

Adding machines are being tested electronically for the wear and tear they are expected to receive in five years of actual office operation. The new testing method developed by Clary Corp., San Gabriel, Calif., checks all 1700 parts for performance, structural strength and life expectancy. With electronic input data-handling equipment, machines taken directly from the production line are fed problems which are typical of those in business operations. However, these problems are fed into the machines at many times the normal rate. The results are calibrated, and the conclusion of the tests on any one model gives a complete experience table that tells the story of the machine.

In order to assure uniformity of test results throughout the industry, members of the Investment Casting Institute have approved a new cast-to-size tensile test bar for investment cast materials. The standard is a part of the Institute's program to establish standards for materials and test procedures. The test specimen has ¼ in. dia and was selected from seven or more test bars used in the industry for testing investment cast materials.

With the cancellation of the quota system on six critical materials by the

Department of Defense, tungsten, cobalt, chromium, columbium, nickel, and molybdenum are released for greatly expanded use in the gas turbine industry without restrictions. The Tungsten Institute announced that work is now under way to develop an alloy for use in the 1800 to 2000 F range or higher, and will contain about 50 per cent tungsten.

Some form of official application between the two national councils representing 250,000 professional engineers in the U.S. and Canada has been proposed by Dean Thorndike Saville of the New York University College of Engineering. These are the Engineers' Council for Professional Development, and the Engineers' Joint Council. While not proposing a complete merger of the two groups, Dean Saville pointed out that there would be advantages in simplifying the underwriting of both organizations, which now requires separate budgeting and underwriting of both organizations. The two organizations recently requested a $1-million survey of the engineering profession and the problems that confront it, such as: education, utilization, and organization of engineers and social and economic connected with the national welfare.

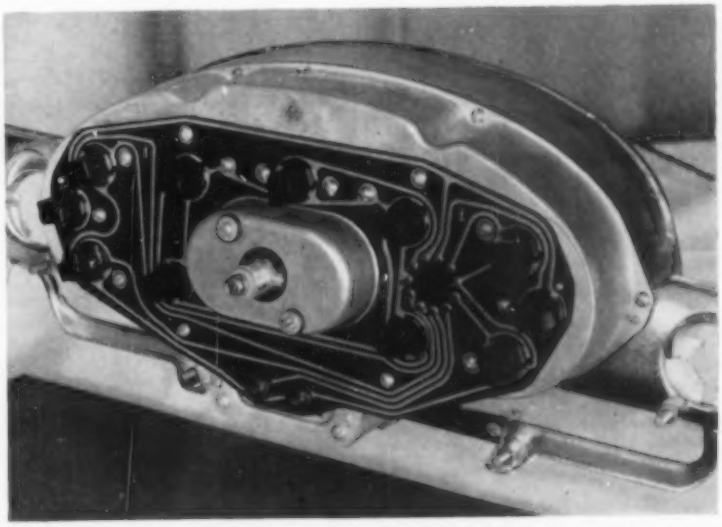
Mechanical and pneumatic signals now can be converted to direct current for long range transmission and then reconverted to pneumatic pressure for actuating control valves or other pneumatic equipment with a new system developed by the Fielden Instrument Div., of Robertshaw-Fulton Controls Co., 2920 N. Fourth St., Philadelphia 33, Pa. The system will permit low cost remote measurement, indication, recording and controlling of process variables by the elimination of electronics and complex circuitry. According to the company, the first commercial installation of the device, called the P-E-P transmission system, will be made in the chemical industry. The transmitter unit uses a flexure-mounted beam and pneumatic nozzle as an error detector and power amplifier to convert a pneumatic signal to an electric signal. This transmitter unit converts pneumatic signals of 3-15 psi or equivalent mechanical outputs into 3-15 milliamperes direct current for electrical transmission. A receiver which is part of the P-E-P system, then converts this d-c signal to pneumatic pressure of 3-15 psi.

Boeing Airplane Co., Seattle, Wash., has come up with a new method for checking its fuel tanks for leaks. Bromocresol Purple is sprayed or brushed on the outside of a tank pressurized with ammonia fumes or other gases. If there is a leak in the tank, the yellow coating at that point will turn purple. When the test is completed, the chemical coating, which is like yellow chalk when it dries, may be blown off the tank with an air hose, or wiped off with a cloth. The gas used is harmless, having only 50 parts of gas per million of air. The method is adaptable to all enclosures, meaning that a tank may be tested in the jig where it is being assembled. Boeing is using the new method in its KC-125 jet tanker-transport manufacturing program, and claims to be saving 75 per cent of time and money, compared to previous methods of testing.

Standardization Urged For Radiation Effects On Materials

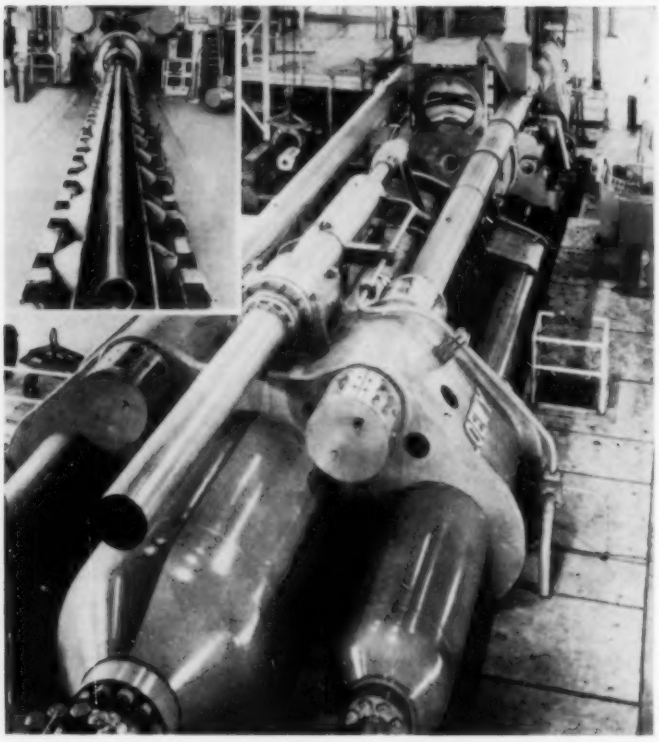
The effects of nuclear and high energy radiation on the properties of plastics and electrical insulations will be studied by a subcommittee of the American Society for Testing Materials. The object of the subcommittee, will be to establish standardization in the field of radiation effect. The data already existing is presently confusing for several reasons: (1) different sources of radiation are employed, (2) different methods are used to determine and express the radiation doses which have been received, (3) the irradiations are done under differing condition of atmosphere, temperature and time, and (4) because different test methods are used to evaluate the results.

Anyone interested in assisting the work of this committee is invited to write to the chairman, D. S. Ballantine, Brookhaven National Laboratory, Upton, New York.



THE BACK SIDE OF the instrument panel in the 1957 Oldsmobile, showing for the first time in the automotive industry a printed circuit for the instrument cluster. Printed on the insulating plate that forms the reverse side of the instrument, the circuit board replaces 14 separate connections, reduces short circuiting, and simplifies maintenance. Also on the 1957 Olds, the Rocket engine has been jumped from 240 to 277 hp, with an increased engine displacement from 324 to 371 cu in., plus a torque increase from 340 to 400 ft-lb at 2800 rpm. Compression ratio is up to 9.5 to 1. Engine exhaust ports are 20 per cent larger to improve scavenging. Piston stroke has been increased by $\frac{1}{4}$ in. and bore dia by $\frac{1}{8}$ in. Four of the five main bearings have been changed from Durex alloy to aluminum, as has the connecting rod bearing material.

THE NEWS IN PICTURES

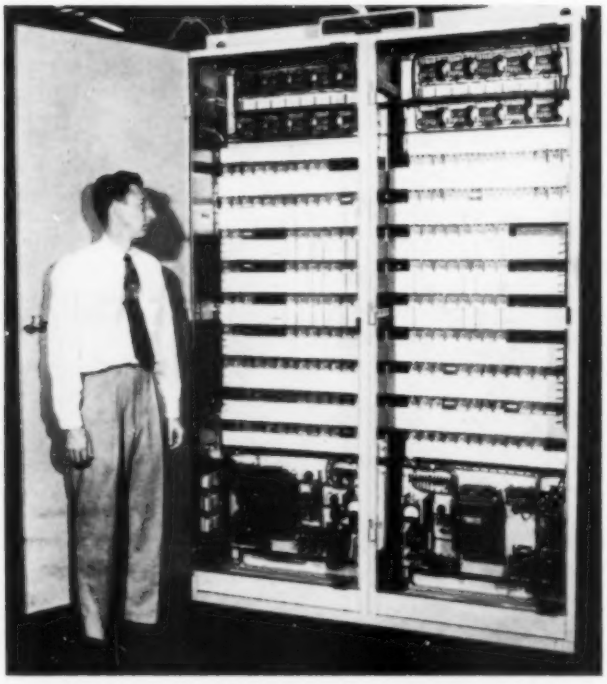


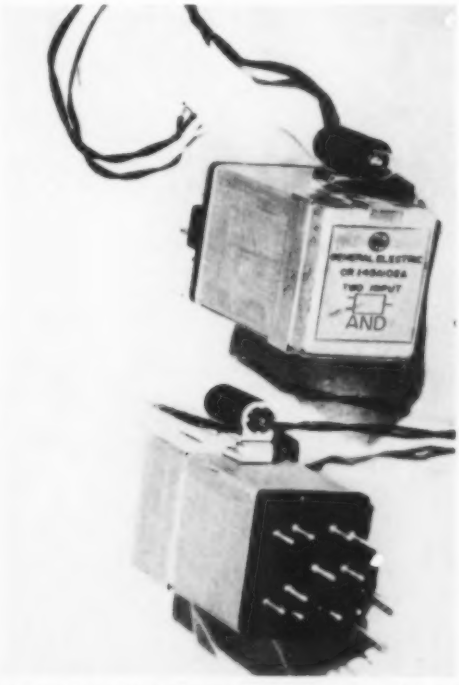
THE ONLY PRESS IN THE U. S. AIR FORCE Heavy Press Program for the extrusion of steels and large titanium components has been placed in operation by the Metals Processing Div., of Curtiss-Wright Corp., Buffalo, N. Y. Capable of exerting a pressure of 12,000 tons, the 126 ft long press was designed by the Loewy-Hydropress Div., of Baldwin-Lima-Hamilton Corp., Philadelphia, Pa. Inset view shows a 50 ft long tube, 6 in. in dia, extruded in nine seconds. One thousand feet of ½ in. spring steel rod is extruded in three seconds. Aircraft components made of titanium and cladded stainless steel sections are presently being produced

STANDARD RAILROAD WHEELS from 30 to 48 in. in dia can be tested on this inertia dynamometer, considered the world's largest, at the U. S. Steel Corp.'s Applied Research Lab. in Monroeville, Pa. The dynamometer consists mainly of a mill-type electric motor, a variable-weight fly wheel, a track wheel, a spring loading device, a braking mechanism, and automatic and manual controls. With all 14 removable disks on the fly wheel, the dynamometer when rotating at top speed is capable of imparting 68.5 million ft-lb of energy to the test wheel. A large locomotive with 40 in. dia wheels and traveling at a top speed of 120 mph dissipates about 15 million ft-lb of energy in braking to a stop. A feature of the machine is its ability to simulate the loading and tracking of a wheel on the rail. A 9 ft dia track wheel with the head of a standard 132 lb rail around the periphery is rotated by frictional contact with the test wheel. To duplicate tracking, the 9 ft wheel can be oscillated laterally as much as 2½ in. at rates up to 60 cpm.

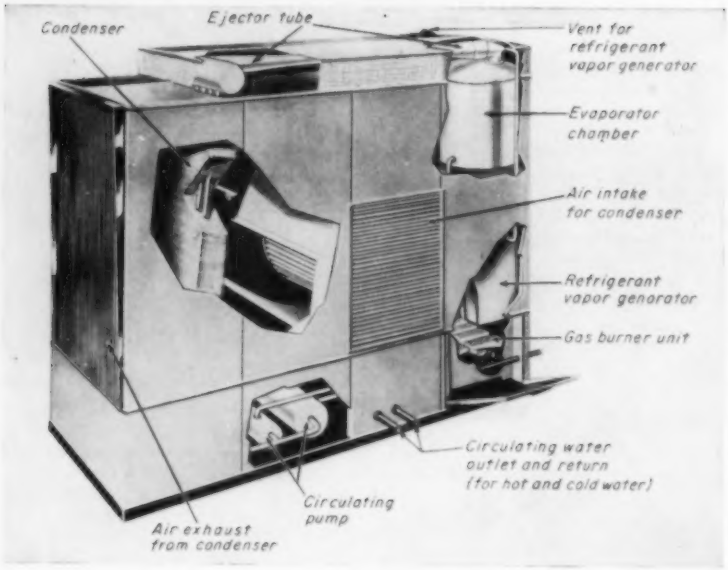
COMPLETELY SUPPORTED BY AIR, this 80 ft long, 40 ft wide and 20 ft plastic building weighs about 400 lb, costs about $2000, and can be set up by three men in one hour. Developed by the United States Rubber Co., Mishawaka, Indiana, the portable warehouse is made of a thin, vinyl-coated nylon fabric called Fiberthin, and is considered particularly suitable for food manufacturers who require seasonal temporary storage for package goods during peak production months. The building is anchored to the ground by a Fiberthin tube 15 in. in dia, extending around its base and containing 23,000 lb of water. The building folds into a package 5 ft long by 3 ft wide and is erected by low pressure air from a compressor or blower. The compressor maintains a constant air supply which will enable the building to retain its shape even when the door is opened for fork lift trucks carrying in goods to be stored. The portable building will be leased and sold through the Calumet Industrial District Co., 1501 E. 96th St., Chicago, Ill.

LOCAL BATTLE AREA surveillance of enemy movements despite smoke, darkness, or fog, is simplified with this small, lightweight, radar set, developed by the Sperry Gyroscope Co., Great Neck, N. Y., for the Army Signal Corps. Considered the smallest radar set yet developed, it has a maximum range of 6000 yards, and is self-contained in a drum-shaped metal case 14 in. in dia, and 14 in. long. Lightness and ruggedness was attained by eliminating a cathode ray tube and substituting audible signals. The set produces distinctive sounds when contact is made with a vehicle or soldier. Power is supplied by a lightweight motor generator.





A COMPLETE static switching control system that performs the same control functions as accomplished by the contact making devices has been announced by General Electric Co. as an aid to the automation of various low-power switching operations. The system consists of a complete line of static components to provide the five logic functions to intelligence switching: "and," "or," "not," "memory," and "time delay." The new switching control can be furnished in completely engineered panels and systems (above, left), or in component form (right) for the control designer. The designer of the new unit permits it to be combined with available regulating systems of the static type. Wear, fatigue, and other factors, according to GE, will be eliminated because the switching devices are encapsulated, and have no moving parts.



Single Gas Burner for Airconditioning-Heating Unit

A new approach to the combination home airconditioning-heating units by Rheem Mfg. Co. has the complete unit in a cabinet 4 ft long, 2 ft wide and 4 ft high which can be placed outside the home instead of taking up basement floor space. Using the conventional ductwork of a hot air heating system, the furnace is eliminated, and is replaced by a small cabinet enclosing a finned coil and a high capacity blower. Chilled water is circulated through the coil for summer airconditioning, and the blower sends cool air through the ducts. In the winter, hot water is pumped through the coils.

Using the jet principles of cooling, a small jet discharges refrigerant vapor inside a specially shaped ejector tube. This causes a drop of several hundred degrees in the vapor as it comes from the jet. The high speed of the discharge draws off vapor of the refrigerant which is maintained in an evaporator chamber connected to the ejector tube. With the evaporation in the chamber, there is a cooling of the circulating water.

Low temperatures are maintained by relieving the ejector tube of pressures that would ordinarily be built up by jet action. Rapid condensing in the air-film condenser is responsible for the pressure reduction.

When used for heating, the vapor condensing phase of the operation ceases. The jet discharge is diverted into the evaporator chamber, heating water that is being circulated in the coil, before it goes either to the finned coil in the blower cabinets, or to the hot water heating system.

While the operation of the new unit is based entirely on the use of a single gas burner unit, it can replace oil fired units in homes where a circulating hot water piping arrangement has already been installed. For summer cooling, the chilled water is sent to small convector units located in each room of the house. Each convector has its own fan for circulation. Or, the radiant heat piping can be eliminated and the wall-type convector units used for heating as well as cooing.

The unit shown here is comparable to a 3 ton airconditioning unit, and total horsepower of all the motors in the unit is less than 1 hp. Rheem does not expect to market the system before 1958, but expects its first cost to be equal to that of a comparable airconditioning unit and a heating unit used in the home. Rheem says, however, that its combination has the efficiency advantage where users will save.

Federal Research Results Now Easily Obtained

Federally supported basic scientific research of an unclassified nature will henceforth be made more widely available to scientists everywhere under terms of a new program announced by the National Science Foundation. With support from the Foundation, the Library of Congress and the Office of Technical Services of the Department of Commerce will attempt a wider dissemination of information in some 20,000 unclassified technical reports on basic research issued annually by the organizations engaged in Government-sponsored scientific research. Specifically, the program, designated government Research Information, is designed to assist any research scientist to:

1. Learn what unclassified scientific reports on government research are being issued in his field of interest and how he can obtain them.

2. Obtain, on a subscription basis, a report-announcement service that automatically will keep him informed, and through which he can purchase copies of listed reports. This is an expansion of an activity which the Office of Technical Services has been offering for several years. OTS publishes the subscription journal U. S. Government Research Reports, a monthly listing of reports on federally supported research.

3. Obtain access to a cataloged reference collection of unclassified scientific reports on federally supported basic research which he can consult at any time.

More information on these services may be obtained from the Government Research Information Clearinghouse, National Science Foundation, Washington 25, D. C.

Engineering Schools Offer Benefits to Keep Faculty

Retaining a qualified faculty despite the tempting offers from industry is still the main problem confronting engineering schools today. According to a survey conducted by the Engineering Manpower Commission, a large percentage of the Deans interviewed were overly concerned about the importance of maintaining the

quality of their staff, and of the danger of oversimplifying the manpower problem by studying simply numerical deficiencies. What many deans fear is the "incidious gradual deterioration" of the staff at the very time that engineering education is facing its greatest task.

To improve their relative competitive position, engineering colleges are taking constructive steps to achieve better working conditions and supplement regular salaries. Colleges not only permit but encourage faculty to take summer jobs in industry. Other compensations include housing allowances or low rental projects, retirement benefits, travel expenses to techincal conventions and increased teaching loads within or outside the institution—such as night classes.

College Students and Draft Deferment

The Engineering and Manpower Commission of the Engineers Joint Council offers the suggestion that more undergraduates think seriously about taking the Selective Service Qualification Test, whether or not they plan to continue with graduate study. Men planning to enter the medical profession have to pass it with a grade of 70 to qualify for deferment. Scientists and engineers must pass it with a grade of 80 or better if they want a II-S deferment to remain in college after graduation.

The original Executive Order 10562 stated that students requesting deferment for graduate study must stand in the top quarter of the senior class in college, or attain a score of 80 on the test. Although the men who stand in the top quarter of the graduating class are the ones most likely to make 80 on the test, many students who did not qualify on the class standing have made the grade on the examination.

Nevertheless, the percentage of draft-eligible college students taking the examination dropped from 32 per cent in the academic year 1950-51, when the test was first given, to 1.2 per cent in the academic year, 1955-56. The 1.2 per cent figure is based on 1,390,000 men eligible to take the test and physically qualified for service.

Limit Bids to U.S. Manufacturers

Members of the Hydraulic Turbine Section, National Electrical Manufacturers Association, claim that the security and defense of the nation depend on a continuing supply of hydroelectric power, and so informed the U.S. Office of Defense Mobilization.

This statement of the Association was in support of their request that bidding on Federal contracts for hydraulic turbines be limited to American manufacturers. The member companies of the NEMA section, which produce over 95 per cent of all the turbines built in the U.S. claimed that: "Foreign manufacturers consistently underbid American hydraulic turbine builders by 30 to 50 per cent."

Streamlined, Functional Telephone

Something new in telephone design and efficiency (a design program continuously under way), the Ericofon shown here was introduced recently by the North Electric Co., Galion, Ohio, at the Annual Convention of the Independent Telephone Industry.

A departure from the conventional two-piece handset-pedestal combination, this one-piece model stands 9¼ in. high and has a base dimension of 4½x3⅞ in. Located in the underside of the base, the dial can be viewed and operated from the most convenient angle possible instead of the usual reaching for the dial set on the desk or table.

Because of the single unit construction, a "standswitch" was designed and is in the underside of the base in the center of the dial. This standswitch performs the usual line connecting function, as in a conventional handset when the receiver is picked up to "hang up," set the unit down on its base.

Light in weight, the manufacturers claim that the Ericofon weighs less than most handsets alone. The case is molded of thermoplastic (available in color) with the receiver permanently sealed inside the upper part of the case (top, left), and the transmitter in the inside lower front part of the base (by thumb of left hand).

The concentration of components in the chassis reduces electrical connections to a minimum. Compared with the conventional telephone, the number of soldering points, terminal screws, wiring, etc., is said to have been reduced by 50 per cent.

The new telephone is available to industry and to subscribers of the Independent Telephone Companies in the U. S.

TECHNICAL NEWS

COMING EVENTS

December 10-12

1956 Eastern Joint Computer Conference, Hotel New Yorker, New York City. The meeting will be jointly sponsored by the IRE, AIEE, and the Association for Computing Machinery. The theme will be "New Developments in Computers." Besides an extensive program of technical papers, there will be many exhibits by manufacturers in the computing field.

December 19-20

Radio-Electronics-Television Manufacturers Association Symposium on Applied Reliability, Bovard Hall, University of Southern Calif., Los Angeles, Calif. There will be sessions on Mechanical Reliability, Information Feedback, and Component Evaluation Usage. Highlight of the meeting will be an evening panel session on "Failure Feedback—Is It Effective."

January 14-16

3rd National Symposium on Reliability and Quality Control in Electronics, Hotel Statler, Washington, D. C. The theme will be a "Report to the Nation on the Present Status of Reliability." There will be two concurrent sessions for four periods during the day.

January 16-18

13th Annual National Technical Conference of the Society of Plastic Engineers, Hotel Sheraton-Jefferson, St. Louis, Mo. Theme of the show will be "Fifteen Years of Plastics Progress." Technical session topics are: Tooling and Machinery; Atomic; Design; Extrusion; Injection; Foams; Applications; Reinforced Plastics; Instrumentation; Compression Molding; Polyethylene; and Epoxy.

January 21-22

Solar Furnace Symposium, Hotel Westward Ho, Phoenix, Arizona. Session topics are: Design and Operation of Large Solar Furnaces; Furnaces for Basic and Applied Research; and Furnace Performance Determination and Control. Following the sessions will be a field trip to see a small furnace at the Arizona State College. There will be an address by Dr. C. C. Furnas, Asst. Sec. of Defense for Research and Development.

January 24-27

General Management Conference of the American Management Association, Fairmont Hotel, San Francisco, Calif. Sessions will be on: Management Development-Principles from Practice; A Practical Operating Management Development Program; Developing Effective Managers in the Small Company; Management Plans and the Washington Perspective; Measuring Management Effectiveness; Standards for Managing Research; Standards for Company Growth; and others.

February 5-7

12th Annual Society of the Plastics Industry, Inc., Reinforced Plastics Division Conference, Edgewater Beach Hotel, Chicago, Ill.

February 26-28

The 1957 Western Joint Computer Conference, Statler Hotel, Los Angeles, Cal. Under the joint sponsorship of the IRE, AIEE, and ACM, the theme of the meetings will be "Techniques for Reliability."

March 11-15

The 1957 Nuclear Congress, Convention Hall, Philadelphia, Pa. Expected to attract engineers and scientists from all over the world, the Congress has as its purpose, the promotion of the use of atomic energy for peaceful purposes in all the nations of the world. The 5th Atomic Energy for Industry Conference will be held in conjunction with the Congress. Over 200 exhibitors will display equipment. In the engineering and science sessions will be 130 technical papers dealing with all phases of nuclear operations. Emphasis will be on new developments of potential value to civilian industry, especially in the field of metallurgy, chemical processing, and mechanical and power applications.

March 13-15

Spring Meeting of the National Fluid Power Association, Hollywood Beach Hotel, Florida.

March 18-21

SPI Annual National Conference and Pacific Coast Plastic Exposition, Los Angeles, Cal. Sessions will be held at the Hotel Biltmore, on plastics in the fields of electronics, aircraft and defense, packaging, building materials, appliances, sheet and cellular plastics, in addition to the latest developments for processes and processing. The Exposition will be held at the Shrine Exposition Hall.

March 25-29

10th Western Metal Congress and Exposition, Pan-Pacific Auditorium, Los Angeles, Cal. The congress will be in the Ambassador Hotel.

April 1-2

5th Midwestern Conference on Fluid Mechanics and the 3rd Midwestern Conference on Solid Mechanics, held concurrently at the Univ. of Michigan, Ann Arbor, Michigan. Designers in the field of mechanics are invited to submit abstracts of papers for presentation at the conference.

April 8-12

American Welding Society, Spring Meeting, Convention Hall, Philadelphia, Pa. The meeting will be held in conjunction with the 5th Welding and Allied Industry Exposition. Several papers will discuss welding problems involved in the design and fabrication of nuclear reactors. Recently developed procedures and techniques for welding reactor components will also be described. A total of 18 sessions are planned. Other papers will discuss welding of titanium and zirconium; brazing stainless steels and high temperature alloys; zinc soldering of aluminum; welding of missile airframes and others.

April 11-13

1957 Southwestern IRE Conference and Electronics Show, Shamrock-Hilton Hotel, Houston, Texas. About 100 exhibitors are expected, and three simultaneous technical sessions will be held.

THE INDEX TO THIS VOLUME HAS BEEN REMOVED FROM THIS POSITION AND PLACED AT THE BEGINNING OF THE FILM FOR THE CONVENIENCE OF READERS

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OOPS!

SIGHTS of rockets swooshing heavenward become more and more familiar as we thumb through today's industrial publications. The recalcitrant rocket shown on this page indicates that things *can* go wrong in research, and we don't claim that the absence of a Sanborn oscillographic recording system somewhere along the line was the reason for this disappointing trajectory.

What we do wish to say is that Sanborn equipment is playing an increasingly vital part in rocket development. Used in the laboratory to record flight behavior simulated by analog computers, and in plotting rooms at testing bases to tape down telemetered data, Sanborn "150's" are helping rockets to get and stay where they belong.

You can see Sanborn systems in many other places, too. Oil fields, electronic component production lines, machine tool plants, hydraulic testing laboratories, numerous aircraft manufacturers, computing facilities . . . are putting single to 8-channel Sanborn systems to work. (Most are housed in vertical mobile cabinets, while those in the "field" are often divided into portable packages for each instrument.) All of them give their users inkless, permanent recordings in true rectangular coordinates, one percent linearity, as many as nine chart speeds, and the efficiency (and economy) inherent in Sanborn unitized design. A dozen different plug-in preamps further extend their value, by making changeover to new recording inputs a quick and easy procedure.

SANBORN COMPANY
CAMBRIDGE 39, MASSACHUSETTS

8-, 6-CHANNEL 4-CHANNEL 2-CHANNEL 1-CHANNEL 2-, 4-, 6-, 8-CHANNEL ANALOG COMPUTER SYSTEMS

Which way rockets are going may not be a primary concern of yours. But if recording problems *are*, you're apt to find some interesting and useful answers in Sanborn's 16 page "150 System" catalog. Write to us for a copy.

If temperature changes are a problem, it'll pay you to use

Adlake

mercury relays

Temperature changes, dust, dirt and moisture can't affect the operation of Adlake relays. They require no maintenance whatever...are quiet and chatterless...free from explosion hazard. Mercury-to-mercury contact gives ideal snap action, with no burning, pitting or sticking. Time delay characteristics are fixed and non-adjustable.

For more information about Adlake Relays, write The Adams & Westlake Company, 1169 N. Michigan, Elkhart, Indiana.

THE ADAMS & WESTLAKE COMPANY ELKHART, INDIANA
New York • Chicago • Established 1857

the original and largest manufacturers of mercury plunger-type relays

Adlake 99th year

Selection Guide for Steels

DOMINIC MASCIO
Engineering Department Supervisor, R. Hoe & Company, Inc.

FOLLOWING TABLE is used as a guide at R. Hoe & Company (manufacturers of printing machinery) in the selection of steels for new designs or re-evaluation of old designs. In addition to information on strength, ductility, characteristics and suggested applications, the table includes relative cost and machinability of each steel based on free cutting steel (AISI-B1112) equal to 100 per cent. Although the relative cost varies with changes in shape, size, quantity, market prices, etc., it is a good base for a cost estimate when switching from one material to another.

For example, in switching from AISI-C1040 (machinability = 63 per cent, cost index = 81) to AISI-4140 (machinability = 57 per cent, cost index = 135), estimate increase in machining cost is 63/57 = 1.10 or 10 per cent, and in material cost 135/81 = 1.67 or 67 per cent.

In selecting between hot and cold rolled steel, it should be kept in mind that hot rolled has a rough surface and to allow extra material for finishing. On diameters up to 2 in. allow $\frac{1}{16}$ of diameter extra for finishing, and on diameters over 2 in. allow $\frac{1}{8}$ of diameter extra.

Cold rolled is smooth with close tolerance but distorts when machined unsymmetrically, as when cutting keyways. This is especially true in long sections. A straightening operation is then necessary. In such cases it is better to use hot rolled. Also the fine finish of cold rolled is wasted when heat treated because of scale accumulation.

In general, an alloy steel should be selected only when one or several of the following properties are required: Better response to heat treatment as indicated by greater hardness, deeper penetration of hardness, and less distortion from heat treatment; greater strength, impact, fatigue, wear, shock resistance, and ductility.

CARBON STEELS

Material Designation	Tensile Strength, Yield Strength, Elongation	Characteristics	Machinability, Cost Index (based on B1112)	Applications
AISI-C1020 Cold rolled steel.	69,000 psi 48,000 psi 30 per cent	Good case hardening characteristics (carburize). Not recommended for through-hardening. Machinability fair. Can be welded brazed, easily bent and formed in the proper anneable condition. (Hard, ½ hard, ¼ hard, and dead soft.)	60 per cent 94	Parts requiring (1) very little or no machining; (2) low cost; (3) case hardening. Studs, pins, collars, spacers, mechanically operated levers, tie bars, braces, slides, fan blades.
SAE-X1020 Hot rolled steel. (AISI-C1022)	69,000 psi 47,000 psi 30 per cent	Properties approximately the same as AISI-C1020 cold rolled steel. Less machinable but more economical for welding since rough surface is satisfactory. Suitable for hammer forging.	50 per cent 73	Parts requiring (1) little machining; (2) low cost; (3) case hardening; (4) welding. Brackets, levers, tie bars, welded assemblies.

(continued on page 213)

YOUR ORDER IS WELCOME

FOR 1 or 1,000,000 BEARINGS

PURCHASE ORDER NO. L-9473

THIS ORDER NUMBER MUST APPEAR ON YOUR INVOICE AND PACKAGE

YOUR **YC** COMPANY
ANYPLACE UNITED STATES

DATE 10/1/56
REQ. BY 10/20/56

TO BOUND BROOK OIL-LESS BEARING CO.
Bound Brook, New Jersey.

PLEASE ENTER OUR ORDER FOR GOODS NAMED BELOW

QUANTITY	DESCRIPTION	PRICE	
6	COMPO bearing #CS-754G1500 .69@	$ 4	14

REC'D OCT 2 1956 B.B.O.B. Co.

ACKNOWLEDGE ORDER AND STATE WHEN YOU WILL SHIP

NO CHARGE TO BE MADE FOR BOXING OR CARTAGE

BY L. M. Black
PURCHASING AGENT

NO PENALTY FOR SMALL ORDERS

Deliveries are prompt. (Immediate delivery for stock bearings.) Write for Stock List No. 4 today . . . . . .

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BOUND BROOK OIL-LESS BEARING CO., EST. 1883, BOUND BROOK, N. J.

Pioneer in

POWDER METALLURGY BEARINGS + PARTS

Selection Guide for Steels (continued from page 211)

CARBON STEELS (continued)

Material Designation	Tensile Strength, Yield Strength, Elongation	Characteristics	Machinability, Cost Index (based on B1112)	Applications
AISI-C1040 Hot rolled steel.	93,000 psi 58,000 psi 27 per cent	Tough and ductile; wear and shock resistant. Good hardenability (relatively high distortion). Small and intricate sections must be heat treated with care. Avoid thin sections in design. Machines to smoother finish than SAE-X1020. Can be surface hardened (flame or induction).	63 per cent 81	Parts requiring high strength and unsymmetrical machining. Shafting, chain sprockets, large gears, forgings such as crankshafts and connecting rods, braces, brackets, ink pump shafts, studs.
AISI-C1040 Hot rolled steel. Turned and ground.	100,000 psi 64,000 psi 22 per cent	Round stock used primarily for long shafting which required greater strength than AISI-C1020 or unsymmetrical machining, such as keyways. Mechanical properties same as AISI-C1040 HRS but twice as expensive.	63 per cent 166	Shafting turned and ground. (Most commonly used steel for this purpose).
AISI-C1095 Hot rolled steel. (also referred to as "drill rod")	106,000 psi 60,000 psi 23 per cent	Can be spring tempered and fully hardened. Avoid stress concentrations. Do not weld or electroplate without precautions to prevent embrittlement. Spring tempered sheets readily punched and blanked. If shape of spring complicated, form in annealed condition and then heat-treat. Good finish. Can be hardened to a RC-57.	42 per cent	(1) For inexpensive spring steel; (2) for use in thin sections only (poor heat treat penetration). Pins, retainers flat and coil springs, clips, washers, steel balls, hot formed springs, dowels, and tools.
1.18 C-Drill rod	106,000 psi 60,000 psi 23 per cent	Water hardening polished steel. Polish after heat treat. No grinding necessary. Can be hardened to RC-61	42 per cent	Can be used for dowels as received. Also for bearing pins when running in direct contact with rollers.

CARBON STEELS—FREE MACHINING

AISI-B1112 Cold Rolled Steel.	82,000 psi 63,000 psi 18 per cent	Free cutting steel. Case hardening recommended for wear resistance only. Unsuitable for parts subject to shock, vibration, or fatigue, or for forming, bending, upsetting, or carburizing. Inherently brittle. For superior properties use C1117.	100 per cent 100	(1) Screw machine products; (2) Parts on which ease of machining and finish are prime considerations. Worms, collets, screws, tie bars, shafts (stationary, pivoting, adjusting)
AISI-C1117 Cold rolled steel.	82,000 psi 74,000 psi 21 per cent	Free cutting steel. Develops uniform, hard case (carburize) and strong, tough core. Carburizes without embrittlement.	90 per cent 100	Free machining parts requiring greater toughness than B1112. Medium duty shafts, studs, pins, screws, worms.
AISI-C1141 Hot rolled steel.	97,000 psi 59,000 psi 25 per cent	General properties similar to C1040 but slightly more machinable and more uniform response to heat treatment. Greater resistance to abrasive wear. Good strength and toughness. AISI-C1141 cold rolled steel comparatively free machining (74 per cent).	67 per cent 103	Parts having good strength and toughness coupled with good machinability. Angle bars, braces, arbors, brackets, screws, shafts spur and bevel grars, studs, worms.

(continued on page 215)

are you killing that still, small voice?

When that voice prods your professional ego with, "You can do bigger and better things!," do you smother it with a wet blanket of doubt?

And when that same voice whispers to you of a gentle climate where the snow is yours just for the asking and sunshine is always yours for the basking, do you clobber it with the sledge hammer of self-denial?

Don't kill that voice! Its wisdom could lead you to a place where you'll find those bigger things, that better life—Firestone. If you've a mind that can matter in the guided missile field, Firestone needs you in its vital development program for the Army's "Corporal," first surface-to-surface guided ballistic missile. Here are just a few of our needs:

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Systems Analysis
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Next time you hear that still, small voice, don't reach for your shotgun. Reach for your pen. Write—right now! Let that still, small voice guide you to big accomplishment for you, big happiness for your family!

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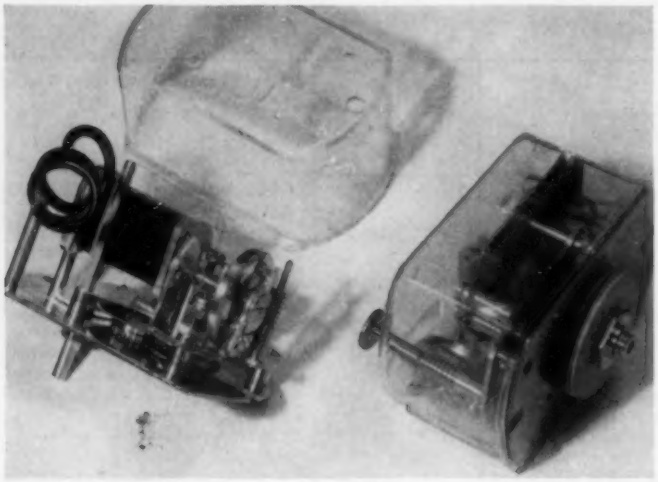
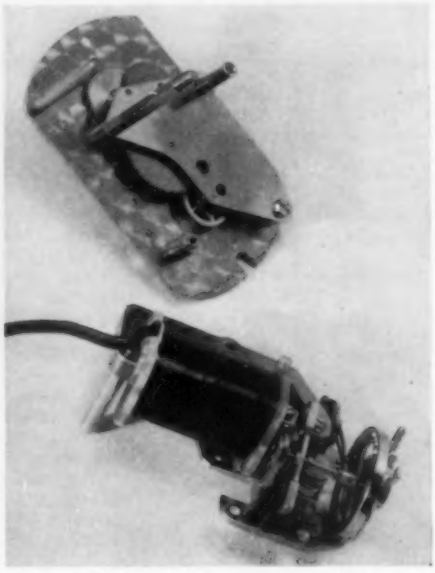
WRITE: SCIENTIFIC STAFF DIRECTOR, LOS ANGELES 54, CALIF.

Selection Guide for Steels (continued from page 213)

ALLOY STEELS

Material Designation	Tensile Strength, Yield Strength, Elongation	Characteristics	Machinability, Cost Index (based on B1112)	Applications
AISI-2340 Hot rolled steel. (Nickel steel).	110,000 psi 80,000 psi 22 per cent	For structural purposes where great strength and toughness are required. Reasonably corrosive resistant. Quench in oil, not water. Little heat treat distortion with deep hardening. Do not carburize or weld.		(1) Small parts subjected to torsion and fatigue; (2) large heavy-duty parts where only simple heat treat is practical; (3) highly stressed parts. Propeller shafts, axles, gears.
AISI-3140 Hot rolled steel. (Nickel-chrome).	96,000 psi 64,000 psi 26 per cent	Heat treats exceptionally well. High impact and fatigue resistance. Suitable under vibration. Readily forged. High creep resistance up to 1000 F. Relatively low cost. Not recommended for severe metal-to-metal wear. Machines well when heat-treated up to 150,000 psi. Max. hardness, RC-55.	55 per cent	Forgings, crankshafts, oil well tool joints, steering knuckles, high temp. valves and fittings, engine bolts valves. AISI-3150 used for small gears.
AISI-4140 Hot rolled steel. (Chrome-moly).	90,000 psi 63,000 psi 27 per cent	High strength, wear and fatigue resistance. Suitable for large sections because it can be deep-hardened and for parts of varying thickness. Good response to simple normalizing treatment or flame hardening. High impact strength at high hardness, if fully heat treated. Difficult to forge and roll. Weldable. Max. hardness, RC-57.	57 per cent 135	Cams, cylinders, rollers, gears, pins, clutch plates, tools, axles, bolts, spindles, shafts, crankshafts, spline drives, heavy-duty tubing. Comparatively low priced.
AISI-4150 Hot rolled steel.	105,000 psi 71,000 psi 21 per cent	Properties same as AISI-4140, but with higher hardness penetration. Max. hardness, RC-56	57 per cent 139 (unleaded) 147 (leaded)	Better hardenability qualities at relatively low cost. Gears, axles, shafts roller bearings, studs.
AISI-4340 Hot rolled steel. nickel chrome-moly).	115,000 psi 95,000 psi 18 per cent	Very high hardenability and strength for medium carbon range. Develops best combination of ductility and strength in heavy sections. High fatigue and torque properties. Anneal before machining. Water or oil hardening often used in very heavy sections. Max. hardness, RC-55.	45 per cent 158	Spiral bevel gears, crank shafts, large forgings (substitute for AISI-3140) large diameter heat-treated shafts.
AISI-4615 Hot rolled steel. (Nickel-moly).	82,000 psi 55,000 psi 30 per cent	Best of carburizing steels. Outstanding for uniformity of case and response to heat treatment. Relative freedom from distortion during quenching and excellent toughness at high hardness. High fatigue resistance. Usually oil quenched, but for extreme hardness, use water. For better machinability, use annealed or normalized.	58 per cent 117	(1) Carburized parts; (2) automatic screw machine parts. Gears, cams, shafts, spindles, bushings, rollers.
AISI-6150 Hot rolled steel. (Chrome-Vanadium)	103,000 psi 70,000 psi 27 per cent	High strength, fatigue resistance, shock and wear resistance, and excellent ductility. Very little heat-treat distortion. Fine grain structure. Poor machinability unless annealed before machining. Do not weld. Max. hardness, RC-58.	50 per cent 132	(1) Parts with varying thickness; (2) Springs subjected to high temperatures, high stress and impact. (3) Parts requiring high strength, impact and hardness, but less tough and ductile.





BALANCE-CONTROLLED MOTOR, above, has output shaft which can be made to provide 1 rev per hr or less. Interval timing unit, shown in housing, is a motor-operated relay or switch. At right is solenoid coil and balance assembly, or motor. The timer's gear box assembly is also shown.

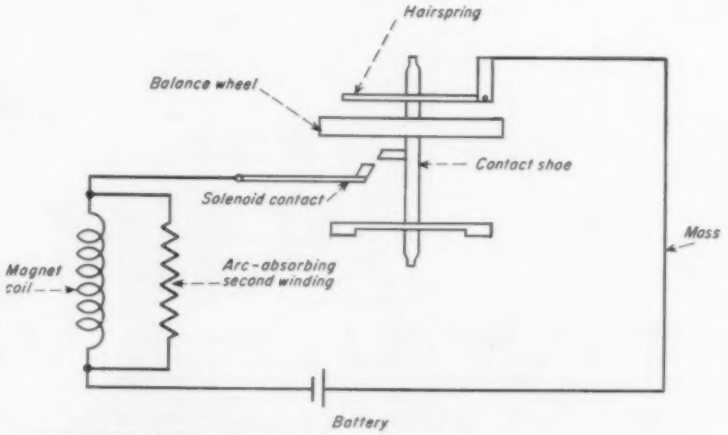
Battery-Operated Motor Uses Clock Movement

A miniature power source of very low current requirements, this d-c motor is for precision timing devices, energized by flashlight-type or mercury batteries. With what the manufacturer describes as chronometer accuracy, unattended operation over months or years is possible. Already used to drive charts and recorders, application to computers, navigational equipment, automatic and telemetering devices, many kinds of switches and control apparatus is expected. The motor is made in Switzerland and tested and regulated in the U.S.A.

The motor derives its power from a balance wheel, pivoted on jewels, which is activated by the magnetic field of a solenoid. On the balance staff is a silver contact shoe, connected to one side of the circuit. The balance staff also carries a bar-type armature which on each swing passes between the pole pieces of the solenoid. The solenoid is energized for very short intervals during each complete swing of the balance wheel, as contact is made between the shoe and the reed-like silver contact connected to the other side of the circuit.

Each complete swing of the balance (every ½ sec) advances a ratchet wheel by one tooth. The torque thus transmitted is amplified at the output shaft by a mechanical advantage of at least 1:7200 (in the case of 1 rev per hr final drive).

Since the period of contact is of such short duration (about 1/30 sec) a single flashlight cell will operate the



SCHEMATIC OF battery-operated timing motor.

motor for months, a suitable mercury cell for years. So small is the current that with the added protection of an arc-absorbing second winding on the same solenoid, contact points are protected against carbonizing and pitting. When the motor is stopped, the balance wheel always comes to rest with contacts closed so that it is self-starting whenever current is restored.

When extreme accuracy is desired, the use of mercury batteries, due to their constant voltage characteristics, is recommended. Accuracy with constant load, using a standard dry cell, is 1/15 per cent; with mercury cell, 1/40 per cent.

Battery life can be estimated from the average power requirement of about 0.002 to 0.003 w, a figure which converts the intermittent current drain which actually occurs into the equivalent of a continuous drain. For example, a single mercury cell with a capacity of 14,000 ma at 1.3 v operated this new motor for over 800 days.

All models can be furnished with standard coils for the following voltages: 1.3, 1.5, 4, 4.5, 6, 12 v.

Output speeds range from 1 rev per hr up to 1 and 2 rev per wk. Torque varies from 0.5 to 9 in-oz. continuous duty, depending on the speed of the output shaft.

Standard mounting position is with axis of balance staff vertical. Mounting positions other than vertical can be provided for on special order.

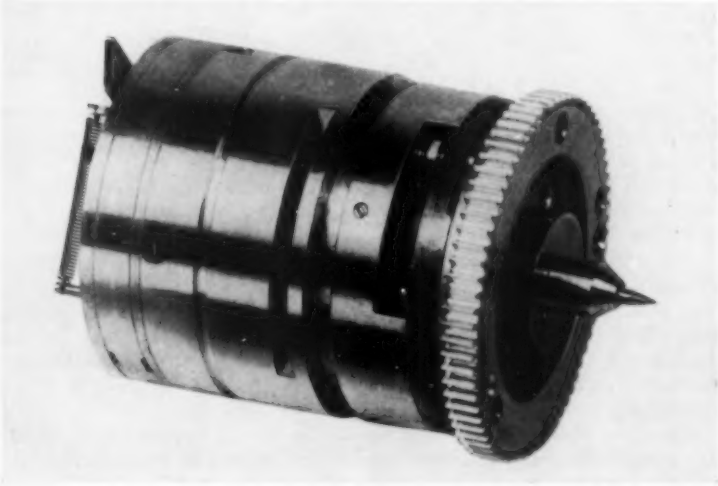
Dimensions of the motor are 2⅜ x 1½ x 1⅛ in. wide. Weight is 4 oz. Shockproof models are available. El Products Co., P. O. Box 41, Kingsbridge Station, New York 63, N. Y.

For more information—
Circe 1, inside back cover

Modular Design Timer

A timing mechanism said to be capable of a variety of control applications is composed of three cylindrical cartridge units, each 1¼ in. dia. One of these cartridges or modules houses a main spring and provides mechanical driving power for operating the entire unit. A second module houses the time measuring mechanism, which is essentially a ruggedized watch. The third module houses the control unit, which comprises a cam driven by the power unit, at a rate controlled by the timing mechanism. This control unit can be provided in a form which permits opening or closing of electrical circuits at desired time intervals, or in a form which provides a mechanical impulse at the end of a preset time interval.

The power supply (mainspring) modules are available in several different spring sizes, to provide both different operating torques for the control unit and timer operating periods of different lengths (from 1 hr to 8 days). The watch module is made in several different standard movements which permit different ranges of time interval measurement (from a few seconds to 168 hr). The control element modules are also available in a variety of standard forms, to provide a variety of different time delay triggering or timed circuit control actions. The units will time accurately (within ±1 per cent) from −65 F to 165 F, and may be calibrated to time within ±0.1 per cent at any temperature within this range. Will withstand accelerations of up to 3000 G applied for up to 10 millisec. Allied Products Division, Hamilton Watch Company, Lancaster, Pa.



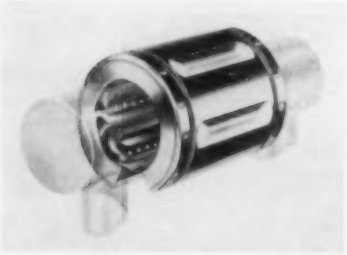
For more information—
Circle 2, inside back cover

Linear Ball Bearing for Supported Shafts

A linear ball bearing has been developed which permits the use of shaft support members along the length of the shaft traversed by the bearings. These bearings are known as open-type ball bushings and are recommended where extreme rigidity or unusually long shafts or ways are a requirement.

The open construction of the bearing also permits adjustment of its bore diameter by use of set screws or other

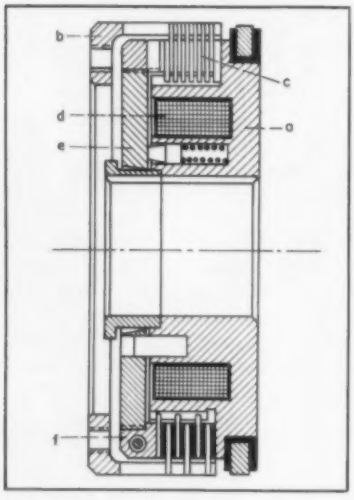
CONTINUED ON PAGE 218



clamping arrangements. The manufacturer states that elimination of shake or play is possible by adjusting for a smooth free-running line-to-line or slight preload fit.

Open-type ball bushings are manufactured to standard dimensions for shaft diameters ranging from 1 to 4 in. Thomson Industries, Inc., Manhasset, N. Y.

For more information—
Circle 3, inside back cover



Electro-Magnetic Multiple Disc Clutch

The clutch is designed for step-by-step acceleration of large masses in main drives, or as an auxiliary or feed drive where precise control and quick response is necessary as in machine tools. Dimensions are said to be small in relation to the magnitude of the torque. The magnetic flux does not pass the disk bundle, therefore the bundle can be designed and formed without regard to magnetic circuit requirements. Disks of various friction materials can be paired to work dry or in oil. Disk surfaces may be of various types suitable to obtain the desired torque characteristics. Torque rating of 10 to 15,000 ft-lb can be obtained. Voltage is 24 v d-c.

The drawing shows the coil member (a) to which the inner disks are geared. The outer member (b) is linked with the outer disks by projecting bars engaged by radial slots located on the outer disks (c). The magnetic flux caused by energizing the coil (d) passes through the working air gap and the armature (e) by-passing the stack of disks. The adjusting locknut (f) presses the disk stack together after the coil is energized. Locknut can be used to vary the force of attraction after coil is energized by altering the length of the working air gap. The lower half of the drawing shows lamination for dry operation. Upper half shows a disk bundle suitable for operation under oil. McCauley Industrial Corp., 219 Parker Ave., Dayton 7, Ohio.

For more information—
Circle 4, inside back cover

Cam-Operated Rotating Limit Switch

A limit switch, designed to facilitate precise synchronization of multiple operations, provides adjustment of each individual contact assembly in relation to its cam. This adjustment can be made with a screwdriver, from the outside, while the switch is in motion.

The switch is made in three standard sizes, accommodating five, nine or twelve cams. The split butterfly cams can be set with a spread between make and break of from 15 to 345 deg, outside in-motion adjustment of ±15 deg.

Contact assemblies have two sets of contacts, one normally-closed and the other interchangeable between normally-open and normally-closed. Contacts are 15 amp capacity, and the arms bearing on the cams have nylon rollers.

Cams are individually adjustable and removable without disturbing the other cams. Contacts can be removed and replaced without disassembling the switch. The switch is designed to operate at speeds up to 100 rpm, and rotation can be either clockwise or counter-clockwise. Clark Controller Co., 1146 E. 152 St., Cleveland, O.

For more information—
Circle 5, inside back cover

Switch Indicates Position And Circuit Connection

A device has been introduced which indicates the open or closed condition of a switch, proving the correct mechanical position as well as the electrical condition. The unit pinpoints the failure of an electrical circuit, and measures 2 27/32 x 1⅝ x 1¾ in.

The device is connected by means of four color-coded wires, two being connected to the 115-v, 60-cps line, and two across the switch.

A small neon lamp is used which is supplied by an isolation transformer through a current-limiting resistor, with sufficient voltage to cause ionization. The switch is connected across the neon lamp through a resistor. If the switch is open, the neon lamp is illuminated. When the switch is closed, the resulting voltage drop causes de-ionization of the neon lamp.

This device meets JIC requirements as well as the rules of the National Electrical Code. Doyle Design & Machine Co., 51 Scio St., Rochester 4, N. Y.

For more information—
Circle 6, inside back cover

Remote Positioning System

This remote positioning system has a torque capacity independent of error signal magnitude, high speed operation without overshoot or oscillation, small size actuator with exceptionally high torque capacity, positioning accuracy with low dead band. The systems have been designed for industrial applications and operate from 115 v a-c, 60 cps power.

The basic components are an amplifier and a high torque motor hav-

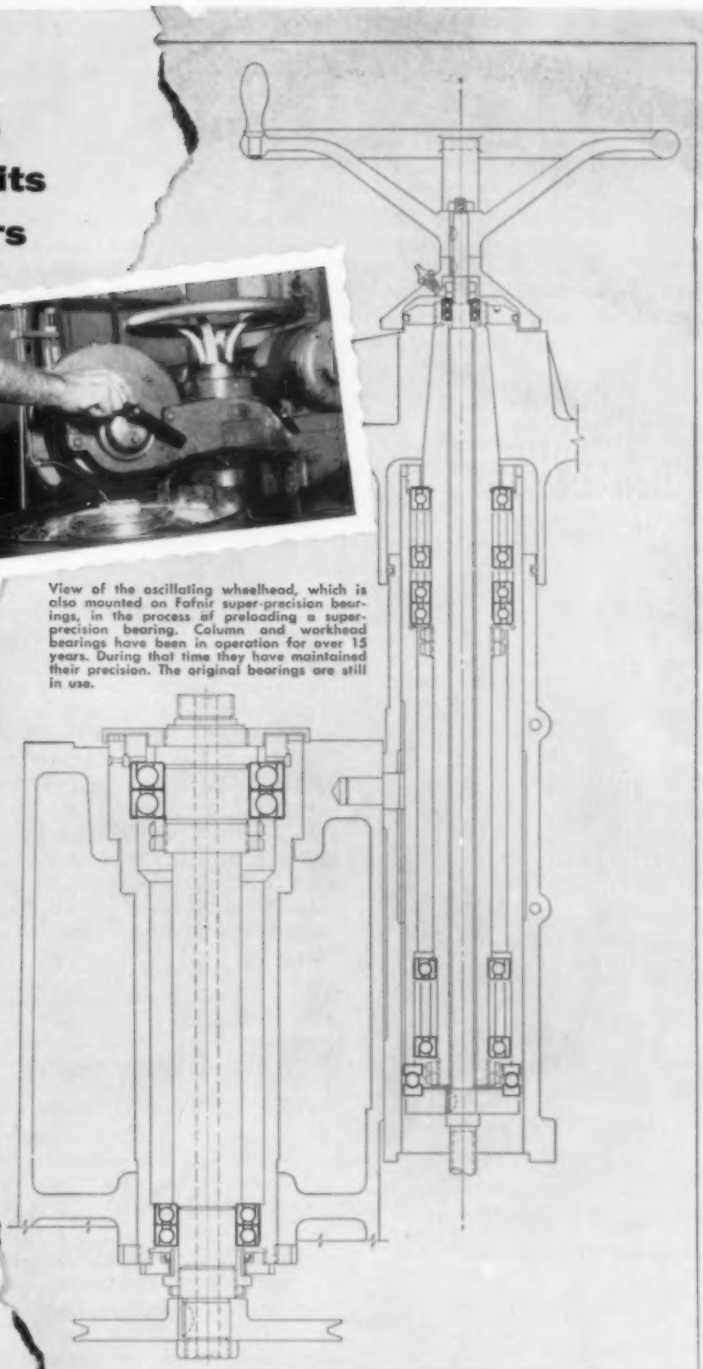
CONTINUED ON PAGE 220

How a precision surface grinder is designed to hold its precision for years

The job of preloading super-precision ball bearings calls for grinding precise amounts of stock from the faces of bearing rings. To obtain such results with a satisfactory degree of efficiency requires a grinder designed to maintain maximum rigidity and precise swiveling of its wheelhead arm plus precise rotation of its work spindle.

The diagram at the right shows how such rigidity is built into a precision surface grinder. All bearings indicated except the thrust bearing at the bottom of the column which supports the wheelhead arm are Fafnir super-precision, preloaded types. The use of these Fafnir ball bearings has resulted not only in work of dependable accuracy and finish, but also longer machine life. For other application data on Fafnir super-precision bearings plus dimensional and load rating details, write for Fafnir Precision Ball Bearing Catalog. The Fafnir Bearing Co., New Britain, Conn.

View of the oscillating wheelhead, which is also mounted on Fafnir super-precision bearings, in the process of preloading a super-precision bearing. Column and workhead bearings have been in operation for over 15 years. During that time they have maintained their precision. The original bearings are still in use.

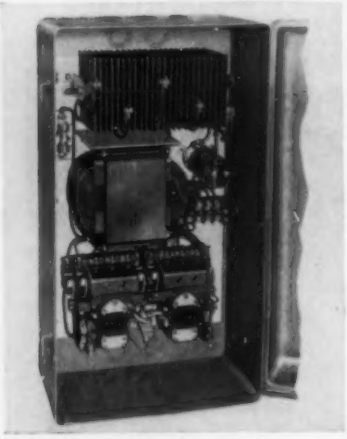


FAFNIR
BALL BEARINGS
MOST COMPLETE LINE IN AMERICA

ing excellent starting and stopping features. The amplifier supplies power to the motor as required to cause the feed-back potentiometer to balance the position manually set on the potentiometer mounted on the amplifier. Torque capacities are up to 100 in-lb, depending on output speed, for which standard gear ratios are available up to 100 rpm. Actuator output speed will correspond to speed of input control up to the limit of specific actuator used.

A separate input for control from other transducers or switching circuits gives this system desirable flexibility for any application where automatic programming or remote positioning is required. A variety of actuator shapes are also available. Globe Industries, Inc., 1784 Stanley Ave., Dayton 4, Ohio.

For more information—
Circle 7, inside back cover



Packaged Control and Braking Systems

These systems can be applied to all standard a-c motors, according to the manufacturer. Through electrical braking, braking torque diminishes as the motor decelerates until a smooth, definite stop results, normally in the same time required for acceleration of the driven equipment. There is no possibility of reversing. Self-contained in NEMA 1 or 12 enclosures, controllers can be installed without any mechanical alterations. Motor maintenance needs are limited to that normally necessary for standard a-c motors.

Braking controllers are available with a braking unit only or as a complete braking and starting unit for either non-reversing or reversing service. A circuit breaker, a fusible or non-fusible disconnect, and other modifications can be added to any of the systems. Westinghouse Electric Corp., P. O. Box 2099, Pittsburgh 30, Pa.

For more information—
Circle 8, inside back cover

Seamless Rubber Drive Belt

A seamless rubber belt that is reported not to stretch has a straight-line cord interliner, vulcanized between two layers of synthetic rubber. Belts can be made in many lengths, widths and thicknesses. They can be produced in almost any type of rubber, including nitrile, styrene, neoprene and natural rubber or in combinations. The cord interliner may be any size from fine yarn to tire cord that specific end uses require. The belt is manufactured in both black and white. Armstrong Cork Co., Lancaster, Pa.

For more information—
Circle 9, inside back cover

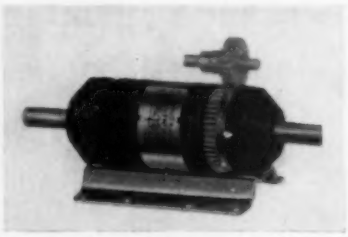
Nut Has Lock in Center

This lock nut can be applied from either end. It is double chamfered with the locking section in the center. An open end and closed end acorn type nut with this same type of lock are also available.

This fastening will lock wherever it is turned on a bolt, because it does not depend on friction against the work. Locking ability is derived from controlled upward and downward displacement of the central threads of the nut.

At the present time the nut is offered in sizes from $\frac{1}{4}$ through $\frac{1}{2}$ in. in either fine or coarse threads. Grip Nut Co., S. Whitley, Ind.

For more information—
Circle 10, inside back cover



Miniature Differential

These differentials will add or subtract two rotating or angular inputs. They are for use controlling relative speeds, obtaining speed ratios between shafts, or reversing or changing speeds without disconnecting power source. Thirty-four ratios, from 1:1 to 27:1, are available.

Backlash between in-line shafts is 4 deg or less. Units with an antibacklash accessory are also available. Internal backlash on these units is held to 15 min or less. Metron Instrument Co., 432 Lincoln St., Denver 3, Colo.

For more information—
Circle 11, inside back cover

Sintered Brass Nuts

Brass powder nuts are made by compacting and sintering powder into cored blanks, which are then threaded. They can be made in any desired shape, with very close tolerances, and with tensile strengths of 30,000 to 35,000 psi.

The nuts are made in widths from $\frac{3}{32}$ to $\frac{7}{16}$ in. and thickness from $\frac{3}{32}$ to $\frac{11}{32}$ in., with a wide range of hole and thread sizes. Midwest Sintered Products Corp., 13605 S. Halsted St., Chicago 27, Ill.

For more information—
Circle 12, inside back cover

Custom D-c Solenoids

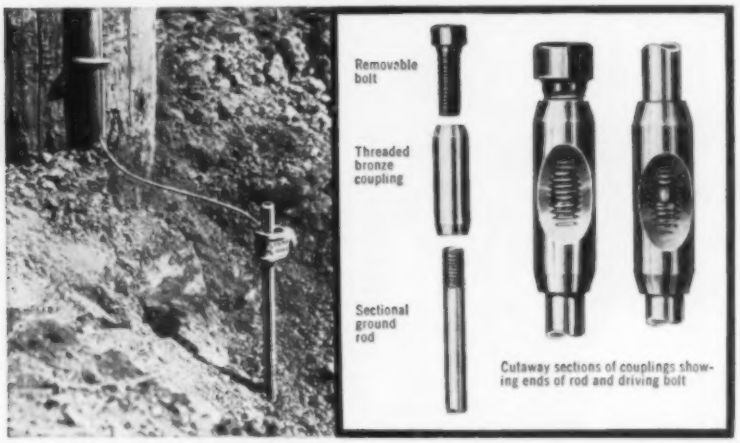
These miniature solenoids may be assembled from 20 standard parts. Typical of the series is Model SO-151: coil, 1500 ohm wound on molded nylon bobbin; dielectric strength, 1200 v, coil to frame; stroke—from $\frac{3}{32}$ up to $\frac{1}{4}$ in.; pull with $\frac{7}{16}$ in. stroke, 9 oz at 110 v d-c. Dimensions, 1.437 x 0.750 x 0.968 in. high. Weight, 2.6 oz. With

CONTINUED ON PAGE 222

BRIDGEPORT BRASS COMPANY

COPPER ALLOY BULLETIN

Bridgeport Brass Co. — Reporting new developments in copper-base alloys and metalworking methods.



Cutaway sections of couplings showing ends of rod and driving bolt

Bridgeport Silicon Bronze Gives Ground Rod Couplings Added Strength, Corrosion Resistance and High Conductivity

Lawrenceville Screw Company, Pittsburgh, Pa., makes a variety of products, among them couplings for Copperweld sectional ground rods. These couplings are produced in a variety of diameters and wall thicknesses to fit a wide range of rod diameters. The most popular sectional rod sizes are 8 and 10 feet. Each rod is made with rolled threads at both ends which screw into the couplings, permitting assembly of any number of rod lengths. By coupling together successive rods, the ground rod is made long enough to reach permanently good conducting soils. One such installation exceeds 200 feet in depth.

Machinability and Strength

Lawrenceville has found that Bridgeport Silicon Bronze No. 707 offers the exact combination of properties essential for both production and finished coupling. The uniform structure of this alloy permits efficient, close-tolerance machining. The manufacturer cuts class 2 threads for $2\frac{1}{2}''$ on the internal length of the coupling, holding to .003″ tolerance on the inside diameter. In addition, the high strength of Silicon Bronze No. 707 is ample to meet the stresses at rod joints and provide secure coupling. Ideal rod conductivity is achieved by the copper-to-copper connection which Silicon Bronze No. 707 provides.

Composition

Silicon Bronze No. 707 is a standard Bridgeport alloy, approximately 91% copper, 7.5% aluminum and 2.5% silicon. It is a high-strength, corrosion-resistant alloy with a machinability rating of 60. Silicon Bronze is 9% lighter and about 50% stronger than annealed Naval Brass rod and has twice the endurance limit. Its tensile strength in the annealed condition is about 90,000 pounds per square inch and its corrosion and wear resistance are, in most instances, superior to brass.

Saves Weight

Forty to 50% lighter than Naval Brass, Silicon Bronze No. 707 offers substantial savings in weight and space without sacrificing resistance to corrosion and wear. Among some of the many items for which Bridgeport Silicon Bronze is well suited are valve parts, wire and cable connectors, nuts, thrust screws, gears, pinions, pump parts, rollers, worm gears and oil-burner nozzles.

Tips on Machining Silicon Bronze

The tensile strength of Silicon Bronze No. 707 in the annealed state is 90,000 psi with a Rockwell hardness of B85. Though its chips are brittle and break off similarly to leaded screw machine brass, the aluminum-silicon content of the alloy makes it tougher and requires a machine some 25 to 30% larger than would normally be used for leaded brass rods.

Use of Correct Coolant

Because friction between the tool and silicon bronze is considerable, the heat generated must be dissipated as quickly as possible. The coolant-lubricant must, therefore, be well directed and in plentiful supply. Generally, best results are achieved with a mineral oil.

Typical parts made from Bridgeport Silicon Bronze

Tool Hardness

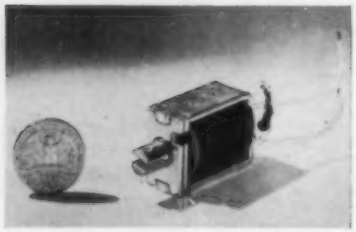
Highest possible hardness is recommended for tools used to machine silicon bronze. For example: a form cutter with a C-65 Rockwell lasted four hours longer than the same tool with a C-62 hardness under the same conditions. For long runs, cast metal or carbide-tipped tools offer longer tool life and permit increased machining speeds.

Wide Selection

Silicon Bronze is only one of the many alloys developed by Bridgeport to meet specific, and often unique, requirements. Find out how Bridgeport alloys can help you in the design of a new product, or the more efficient production of a present item. Call your nearest Bridgeport Sales Office for experienced helpful service and prompt delivery. (0248)

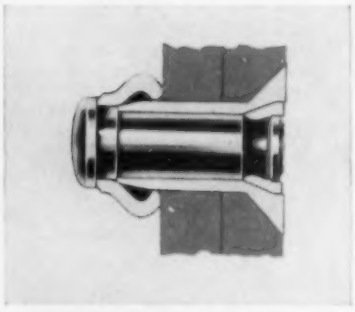
BRIDGEPORT BRASS COMPANY ♦ BRIDGEPORT, CONNECTICUT

Mills at Bridgeport, Conn., Indianapolis, Ind., and Adrian, Mich. Sales Offices in Principal Cities—Conveniently Located Warehouses



variations of wire size, coil resistance may be varied between 0.004 up to 8200 ohms. Coils can withstand 8 w continuously and as high as 70 w intermittently with standard insulation. Joseph Pollak Corp., 81 Freeport St., Boston 22, Mass.

For more information—
Circle 13, inside back cover



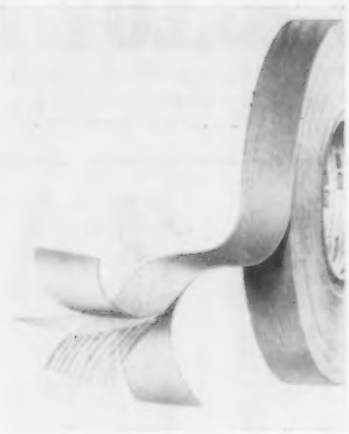
Blind Fastener of Heat-Treated Steel

The fastener is of pin and sleeve design with a positive mechanical lock provided by a one-piece steel collar, which is driven into a locking groove in the pin at the point of maximum tension. The bolt is available with countersunk or brazier head in grip ranges to meet average requirements. Production at present is limited to ¼ in. dia size. Huck Mfg. Co., 2482 Bellevue, Detroit 7, Mich.

For more information—
Circle 14, inside back cover

Vinyl-Back, Glass-Reinforced Tape

A 250 lb tensile strength, pressure-sensitive reinforced tape is said not to cut into the edges of packages. The tape is available in standard widths starting from ½ in. in 60 yd rolls.



Longer lengths are available on special order. Johns-Manville Dutch Brand Div., 7800 Woodlawn Ave., Chicago 19, Ill.

For more information—
Circle 15, inside back cover

Pressure Differential Relief Valve

In these piston-type relief valves, ¾ and 1 in. sizes, pressure acts on the annular area between the outside diameter and the reduced diameter of the piston. When the pressure acting on this area is equal to the spring force, the valve opens. Effective force of pressure is not reduced by the high velocity-low pressure conditions which occur ahead of the seat.

They are adjustable and work efficiently at any pressure setting between 1500 and 3000 psi. Fluid Control, Inc., 1284 N. Center St., Mentor, Ohio.

For more information—
Circle 16, inside back cover

Subminiature Neon Lamp

The lamp is designed with a subminiature flanged base and will be interchangeable in many assemblies with existing miniature aircraft lamps of the No. 327 to 338 series. Power consumption to 0.04 w. Current drawn is 0.0003 amp. The lamp produces practically no heat. It is a long life unit with average life said to be over 25,000 hr. Starting voltage is 65 v a-c. Circon Component Co., Santa Barbara Municipal Airport, Goleta, Calif.

For more information—
Circle 17, inside back cover

High Ratio Gear Assembly

An in-line gear unit for high gear ratios is suitable for connection to any standard flange-type motor without changes. A range of ratios can be provided, up to 266:1 in single gear stage and to 20,000:1 in two stages.

The device is furnished as a horizontal or vertical unit with output shaft pointing up or down. Present sizes have capacities up to 3000 in.-lb. All units have the input and output shafts in line with the motor. Odin Corp., Castleton, Ind.

For more information—
Circle 18, inside back cover

Pressure-Sensitive Adhesive Film

As a substitute for liquid adhesives and mechanical fastenings, this pressure-sensitive film is adhesive on both sides and has reinforcing tissues. It is adaptable to a variety of porous and non-porous materials and because it is a pliable film instead of a tape, it is said to conform with ease to highly irregular surfaces.

The film is supported by a double-coated release paper, which can be removed at once for instant bonding or at a later date by the consumer. The material can be slit or die cut with protective release paper in place. Comes in rolls varying from ⅛ up to 39 in. width and in lengths to 72 linear yd. Three types: soft, medium

CONTINUED ON PAGE 224

Presenting...

N-A-X® FINEGRAIN

Latest member of the N-A-X family of High-Strength Steels

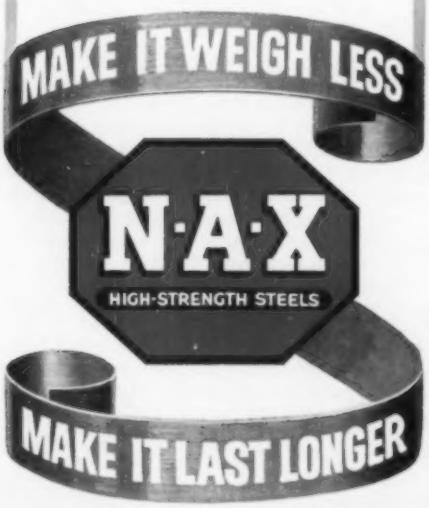
COMPANION HIGH-STRENGTH STEELS TO N-A-X FINEGRAIN

N-A-X HIGH-TENSILE STEEL

A low-alloy, high-strength steel possessing all of the characteristics of N-A-X FINEGRAIN plus enhanced resistance to atmospheric corrosion.

N-A-XTRA HIGH-STRENGTH STEEL

Heat-treated alloy plates of weldable quality having yield strengths of 70,000 psi upwards.



N-A-X FINEGRAIN is a low-alloy, high-strength steel with many diversified applications in modern metals design. Compared with carbon steel—

- **It is 50% stronger.**
- **It has high fatigue life with great toughness.**
- **It has greater resistance to wear or abrasion.**
- **It is readily welded by any process.**
- **It is stable against aging.**
- **It polishes to a high luster at minimum cost.**
- **It can be cold formed readily into the most difficult stampings.**

With N-A-X FINEGRAIN you can design lighter weight, longer life and economy into your products. Let us show you how.

N-A-X Alloy Division
GREAT LAKES STEEL CORPORATION
Detroit 29, Michigan • A Unit of
NATIONAL STEEL CORPORATION

and firm. Angier Adhesives, Div., Interchemical Corp., 120 Potter St., Cambridge 42, Mass.

For more information—
Circle 19, inside back cover

Magnetic Friction Clutch

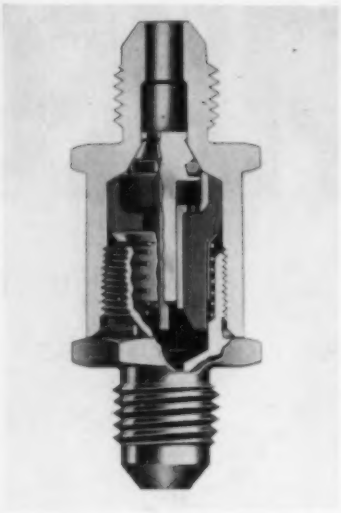
A magnetic clutch for low power servomechanisms is designed to operate on 24 v d-c, delivering 50 in.-oz min. Response time is within 3 millisec. Power consumption is 3 w. Dynamic Instrument Corp., 59 New York Ave., Westbury, N. Y.

For more information—
Circle 20, inside back cover

Pneumatic Pressure Reducer

Reducer reduces pressure from 3000 psi and is designed to conform to MIL-R-8572 A. It weighs from 0.4 to 0.6 lb depending on model and is available in $\frac{1}{4}$ and $\frac{3}{8}$ in. tube sizes. A built-in relief valve is standard, however it may be supplied without relief valve for special pneumatic or hydraulic application. Normal temperature range is −65 F to 225 F for pneumatic systems, with higher temperatures possible with slight modification of the internal design. Pneu-Hydro Valve Corp., 364 Glenwood Ave., E. Orange, N. J.

For more information—
Circle 21, inside back cover



Stainless Steel Check Valves

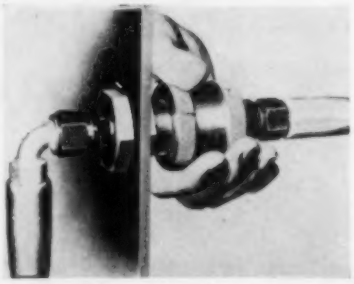
The design protects the O-ring seal on the valve poppet from any damage due to flow turbulence or erosion. As the valve opens, the poppet and O-ring move into a cup-shaped section. Flow passes outside the cage and all parts inside the cage are completely out of the stream.

The check valves are designed for 3000 psi pneumatic service. Actual weight of all valves is less than the maximum of the specification. Sizes 4, 6, and 8 are available in two types, one for 37 deg flared tube fittings, the other for flareless tube fittings. Mansfield & Green, 1051 Power Ave., Cleveland 14, Ohio.

For more information—
Circle 22, inside back cover

Self-Sealing Coupling

This coupling is designed for use on airframe and aircraft engine hydraulic systems with temperatures up



to 275 F and maximum pressures of 300 psi. Functionally, the coupling takes the place of two shutoff valves and is particularly suited for installations where a hydraulic line must be broken for maintenance or test operations. Connection is made by a manual one-quarter turn of the union nut; disconnection is accomplished by an axial pull on the nut. Aeroquip Corp., Jackson, Mich.

For more information—
Circle 23, inside back cover

Convertible Solenoid Valve

The valves can be operated from either an open or closed position, the conversion from one to the other being made by a mechanical rearrangement of the solenoid. The unit is 2 x 1 in. dia. Weight is less than 10 oz. The valves can be used for controlling air, helium, nitrogen, liquid oxygen or corrosive liquids. Clary Corp., Dept. W106, San Gabriel, Calif.

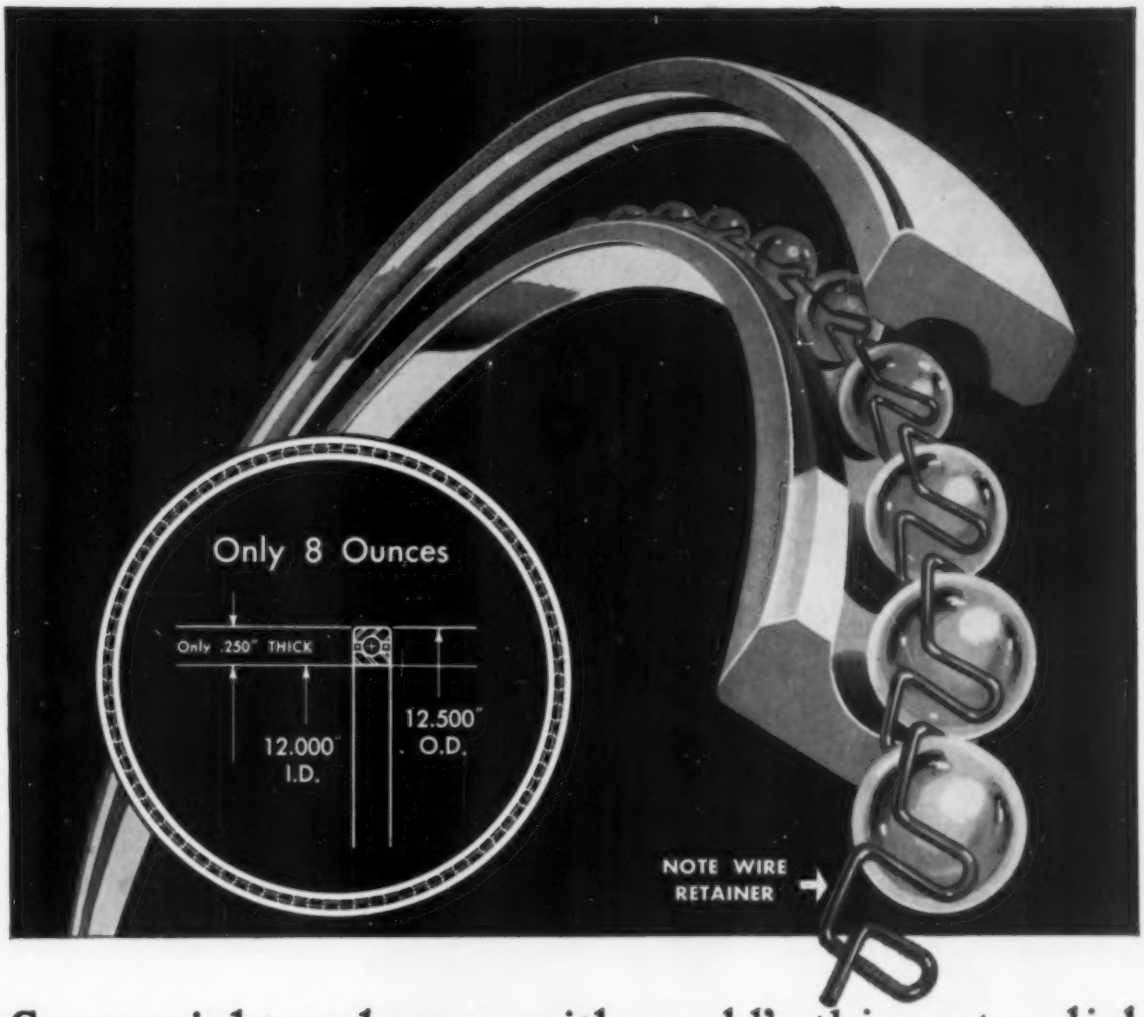
For more information—
Circle 24, inside back cover

Feed and Traverse Power Unit

A power unit that has a pressure-compensated pump with flow control is available with a complete circuit to supply automatic feed and traverse action. The unit has a capacity of 5 gpm at 2000 psi. It is comprised of a JIC 10-gal reservoir and fittings (breather, cap and screen, gage, baffles), a 3 hp electric motor, and a pressure-compensated variable displacement pump and relief valve.

Adapting the equipment to feed and traverse jobs, such as milling,

CONTINUED ON PAGE 226



Save weight and space with world's thinnest radial ball bearings—*Reali-Slim* by Kaydon

HERE it is! A *Reali-Slim* radial ball bearing with a wire separator that has just short of a full complement of balls for maximum capacity. What's more, you still get all the advantages of a separator between the balls. This design also gives you a bearing that's light-in-weight and is, without a question, the thinnest bearing ever built in this diameter.

Whatever your product design, there's a small or large diameter *Reali-Slim* bearing that can be the right answer to your thin-section bearing problems.

The radial ball bearing, illustrated here, is *really slim* — 12.000" I.D., 12.500" O.D., .250" thick . . . *and weighs only eight ounces.* It has 9,810 lbs. static load capacity, 1,256 lbs. at 100 rpm. Kaydon is able to produce *Reali-Slim*, high-precision bearings because Kaydon specializes in the unusual.

Kaydon bearing engineers are prepared to give you valuable help with technical, thin-section bearing problems.

For detailed information on Kaydon's *Reali-Slim* line, ask for engineering catalog No. 54-RS3 detailing:

Reali-Slim Ball Bearings — Conrad, angular contact and 4-point contact types in seven standard cross sections from ¼" to 1.000" and in bore diameters from 4" to 40".

Reali-Slim Roller Bearings — Radial and taper roller types in cross sections from 9/16" and in bore diameters from 5" to 40".

THE KAYDON ENGINEERING CORP.

MUSKEGON • MICHIGAN

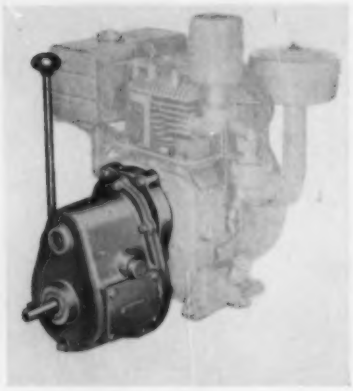
K-561

All types of ball and roller bearings — 4" bore to 120" outside diameter . . .

Taper Roller • Roller Thrust • Roller Radial • Bi-Angular Roller • Spherical Roller • Ball Radial • Ball Thrust Bearings

drilling or pressing operations, is accomplished by using one of two available circuits, one of which produces higher traverse speeds by powering a 2:1 cylinder. Rosaen Co., 1756 E. 9 Mile Road, Hazel Park, Mich.

For more information—
Circle 25, inside back cover



Reverse-Reduction Unit For 5 Hp Engines

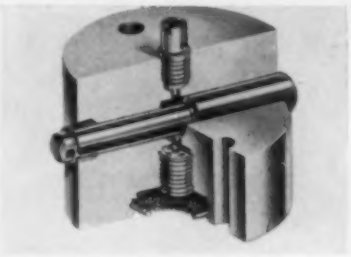
This device incorporates a 2:1 reduction, definite neutral, positive forward and reverse. The unit is fully enclosed in an oil-tight housing which is bolted to the engine crankcase.

The double-acting, clutch with overcenter shift mechanism permits shifting instantly from forward to reverse or neutral at any engine speed. Inching and braking are accomplished with finger-tip pressure on the shift lever. The units have been designed for use with Briggs & Stratton engine Model 14. Adaptation to other engines of comparable sizes (5 hp at 3600 rpm) can be made through the use of adapter plates. J. B. Foote Foundry Co., Fredericktown, Ohio.

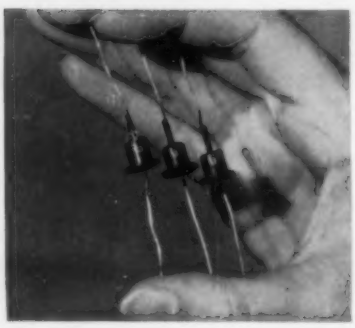
For more information—
Circle 26, inside back cover

Piston-Type Lubricating Pump

Described as a rotating pump with an oscillating piston, the pump consists of a cylindrical housing, about 3 in. dia, containing a horizontal stepped piston. It is designed primarily for lubrication of machines with a vertical drive shaft, and is attached directly to the bottom of such shaft. The pump is mounted on the shaft so that it rotates in a fixed eccentric race in a sump, and the ends of the piston, extending beyond the diameter of the housing, ride against the eccentric race. The resulting oscillating action of the piston draws oil into the pump and feeds it under pressure into the bore of the drive shaft and thence to the bearings. Bijur Lubricating Corp., 151 W. Passaic St., Rochelle Park, N. J.



For more information—
Circle 27, inside back cover



Low Current Silicon Rectifiers

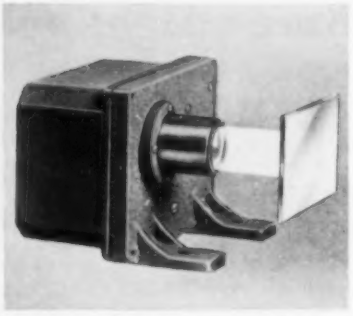
This series of silicon rectifiers is designed for use in aircraft and other airborne computers, guided missiles, magnetic amplifiers, and electronic and electrical equipment operating at high temperature. The rectifiers are rated respectively at maximum peak inverse voltages of 50, 300 and 400 v. Maximum allowable rms voltages are 35, 210 and 280 v, respectively. Ambient operating temperature is from −65 C to 165 C with storage temperature rated at −65 C to 175 C. Maximum rated output current for the series is 750 milliamp at an ambient temperature of 50 C. General Electric Co., Syracuse, N. Y.

For more information—
Circle 28, inside back cover

Hydraulic Piston Pump

The pump has a 3000 psi max intermittent pressure and a rated pressure of 2000 psi. Displacement per revolution is 0.597 cu in. with 2600 rpm max and 8.6 hp. The 25 lb unit will handle 2.8 gpm at 1200 rpm and 4.15 gpm at 1800 rpm. Dynex, Inc., 1500 S. Muskego Ave., Milwaukee, Wis.

For more information—
Circle 29, inside back cover



Photoelectric Control for Transparent Materials

A photoelectric unit that is actuated by glass, cellulose and other transparent materials produces a light beam of short wave length, which these materials interrupt. Control is actuated by the light beam at distances up to 5 ft. Minimum photo-

CONTINUED ON PAGE 228

THOUSANDS UPON THOUSANDS OF THERMOMETAL AND CONTACT ASSEMBLIES A WEEK!

That's normal production for
The H. A. WILSON Company

And these thousands of assemblies from the modern Wilco plant are your assurance that you can profit from the quality and economy that only volume production can give you.

For the H. A. Wilson Co. is a specialist in contacts and thermometals ...and in the unique skill necessary to combine the two for maximum performance. Yes, it's smart to do business with a specialist.

You can't make or buy better Thermometal and contact assemblies at any price. Contact a specialist today— H. A. Wilson Company.

WILCO PRODUCTS ARE:
Thermometals
Electrical Contacts
Clad and overlaid composite metals
Special Alloys

WILCO

The H. A. WILSON Company
2655 U. S. Route 22 Union, New Jersey
Branch Offices: Chicago • Detroit • Los Angeles • Providence

tube light time and phototube dark time is 0.05 sec each.

The control relay energizes when light is on the phototube. Contacts are double-pole, double-throw, rated 8 amp at 115 v a-c non-inductive. Autotron, Inc., Box 722-V, Danville, Ill.

For more information—
Circle 30, inside back cover

Fire-Resistant Hydraulic Fluids

Two fire-resistant hydrolube fluids are said to have good corrosion and wear resistance, in the same general range as petroleum hydraulic oils. These fluids have also been used successfully and safely in ingot manipulators, furnace controls, electric welding machines, and many other industrial applications. Carbide & Carbon Chemicals Co., Div. Union Carbide & Carbon Corp., 30 E. 42nd St., New York 17, N. Y.

For more information—
Circle 31, inside back cover

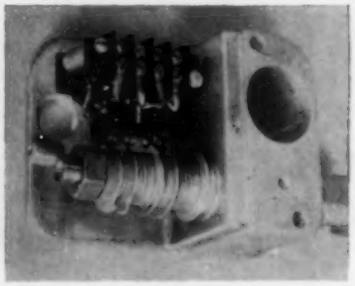
Light Gage Aluminum Tubing Welded

This process welds any aluminum alloy at any hardness into light tubing, from sheet 0.050 in. down to 0.025 in. thick. The tubing is said to have strength properties superior to extruded or butt tubing and is designed for use in applications requiring greater material strength and weight reduction, such as electrical conduit, television and radio antenna, furniture, heat exchangers. Jo-El Co., 14200 Leroy Ave., Cleveland, Ohio.

For more information—
Circle 32, inside back cover

Tension and Velocity Control

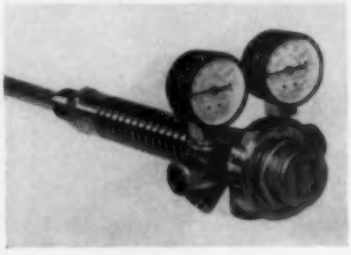
A control for winding and feeding of paper, textiles, metal strip, webs and tapes of all kinds provides automatic tension control from a few ounces up to several hundred pounds, and constant velocity control to several hundred feet per minute. It may be mounted on the frame of the machine or can be had with its own adjustable stand for floor mounting.



Two types of units are available. The limit switch type provides on-off control for drive motors or for pilot motor control of variable speed drives. The proportional type provides control for variable speed drives with the speed-up or slow-down signal proportional to pivot arm movement from the neutral position. For mechanical variable speed drives a balanced bridge follow-up control is used.

The standard limit switches handle pilot motors through ¼ hp. Larger motors are relay controlled. Jordan Co., Inc., 3235 W. Hampton Ave., Milwaukee 9, Wis.

For more information—
Circle 33, inside back cover



Pilot Controller for Higher Temperatures

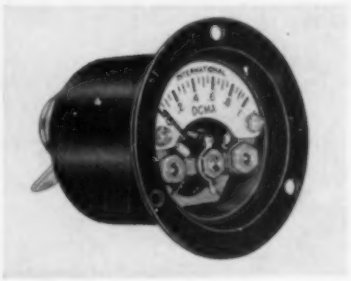
A pilot-type thermostatic controller for higher temperative applications is available in any 200 deg temperature range from 50 to 600 F. The controller measures 3⅛ x 19¾ in. length, and is recommended where compressed air is used as the pilot supply. Fulton Sylphon Div., Robertshaw-Fulton Controls Co., Box 400, Knoxville, Tenn.

For more information—
Circle 34, inside back cover

Lead-Plastic Molding Compound

Developed as shielding for radioactive materials, this compound, containing 95 percent lead, is said to be both harder and more rigid than pure lead. It can be molded into any shape within a tolerance of ±0.0005 in. The amount of lead in the compound can be varied. Telectro Industries Corp., 35-18 37 St., Long Island City 1, N. Y.

For more information—
Circle 35, inside back cover



Round Meter for Flush Mounting

A 1-in. panel meter for flush mounting employs a miniaturized D'Arsonval-type movement. Accuracy is held to ±3 percent of full scale deflection for d-c instruments and ±5 percent for a-c instruments. International Intruments Inc., New Haven 15, Conn.

For more information—
Circle 36, inside back cover

Flareless Tube Fitting

Since a butt-joint is formed and there is no tube entry into the body of the fitting, tubing need not be sprung when making assemblies. Available in steel or stainless steel in a variety of sizes, the fitting consists of a body, nut and alloy steel sleeve.

A shoulder on the sleeve prevents incorrect assembly even by inexperienced personnel. Three serrated edges on the sleeve bite radially into the tube surface to a controlled depth, making a triple seal. It will not move longitudinally in assembly, scrape or shave tubing, and there is no torque

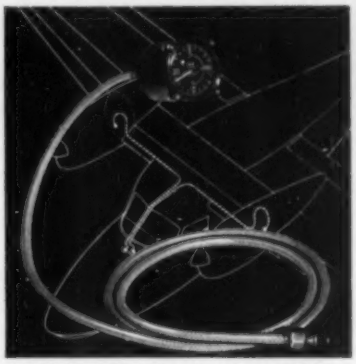
CONTINUED ON PAGE 230

FLEXIBLE SHAFT IDEAS for ENGINEERS

Gain extra design freedom... create cost-saving opportunities with S.S.White flexible shafts

S.S.White "Metal Muscles"® are readily adaptable to a wide range of space, operating and service requirements

BY USING S.S.WHITE FLEXIBLE SHAFTS to transmit power or control between two points, many of the restrictions placed on a design by rigid connections can be quickly removed.



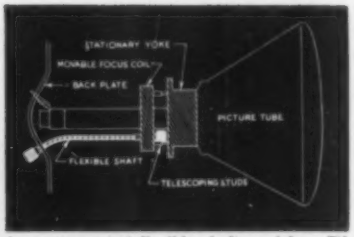
A flexible shaft tachometer drive application.

Save time and costs

Power sources and driven members or controlled parts and their controls can be positioned to better advantage. Costly methods of connection and adapting can be eliminated and general overall design can be improved. And, because an S.S.White flexible shaft does away with alignment problems and reduces the number of parts required for a control or power drive, costly and time-consuming assembly operations can be avoided.

Early consideration best

By far the best time to consider using S.S.White flexible shafts is when your product is still in the design stage. Then you can use them to maximum advantage and will also have a wider selection of shaft sizes, styles and characteristics to choose from than if your design is "locked up."

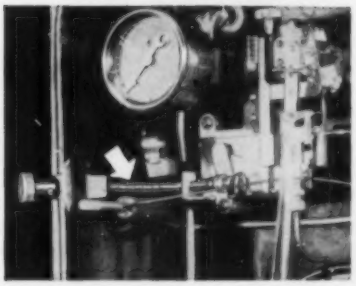


A remote control flexible shaft used in a TV-focusing device.

Satisfaction assured

Once selected, you can always count on S.S.White flexible shafts to measure up to the requirements of your application. S.S.White's many design and manufacturing developments have made S.S.White flexible shafts first in the field for quality, performance and dependability. Experience has shown that when it comes to flexible shafts you'll always be right – if you specify "S.S.WHITE".

"Coupling"... a money-saving flexible shaft idea



SHORT LENGTHS of S.S.White Flexible Shafting, used to "couple" two adjacent parts within the confines of a piece of equipment are a simple economical answer to many power drive and control problems.

Only a single length of shafting is needed regardless of *the relative position of the parts.* The shaft functions satisfactorily without vibration even under conditions of misalignment, thereby insuring trouble-free service and simplifying assembly operations. A typical flexible shaft coupling application is shown above.

Engineering cooperation on flexible shaft application problems

PROPER SELECTION AND APPLICATION *are essential if you are to get the most out of a flexible shaft. The services of our engineers – long experienced in solving all types of flexible shaft problems – are available for this purpose. May we cooperate with you on a specific current problem? There's no obligation. It will save you time and trouble.*

A "must" for every design engineer

Bulletin 5601 contains the latest information on flexible shafts, tells how to select and apply them. Send for your copy today.

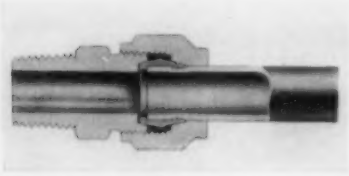
F6-S

S.S.White

FIRST NAME IN FLEXIBLE SHAFTS

S. S. WHITE INDUSTRIAL DIVISION, DEPT. D, 10 EAST 40th ST., NEW YORK 16, N. Y.

Western Office: 1839 West Pico Blvd., Los Angeles 6, Calif.



applied when making a joint.

The fitting conforms to JIC standards and the ASME code for pressure piping. It may be used with steel, stainless steel, copper, aluminum, Monel and other tubing, $\frac{1}{8}$ to $1\frac{1}{2}$ in OD. Imperial Brass Mfg. Co., Dept. HSF, 1200 Harrison St., Chicago 7, Ill.

For more information—
Circle 37, inside back cover

Oldham Couplings for Control Applications

These couplings are for applications where it is necessary to compensate for shaft misalignment up to 0.03 in., or for expansion. Components may be removed without removing shafts. Maximum backlash is 10 min of arc. All-stainless steel construction provided. Available for $\frac{3}{16}$, $\frac{1}{4}$, $\frac{5}{16}$ in. shafts and $\frac{3}{16}$-$\frac{1}{4}$ and $\frac{1}{4}$-$\frac{5}{16}$ in. shaft combinations. Ford Instrument Co., 31-10 Thomson Ave., Long Island City 1, N. Y.

For more information—
Circle 38, inside back cover

Heater Eliminates Dampness, Condensation

According to the manufacturer, keeping equipment 2 or 3 deg warmer than room temperature at all times will eliminate condensation due to daily temperature changes. This can be accomplished by using continuous, well-distributed heat. By using this 25 w, $\frac{3}{8}$ in. dia, 36-in. long heater, convection currents are set up without hot spots. Dampp-Chaser, Inc., Hendersonville, N. C.

For more information—
Circle 39, inside back cover

Bucket-type Steam Trap

A bucket type steam trap for unit heaters, small processing machinery and like applications is available in $\frac{1}{2}$ to 2 in. pipe size. Developed for low pressure-high condensate rate applications. The trap operates on a balanced pressure principle, automatically compensating for differential pressures through a range of 0 to 250 psi. Perfecting Service Co., 332 Atando Ave., Charlotte 6, N. C.

For more information—
Circle 40, inside back cover

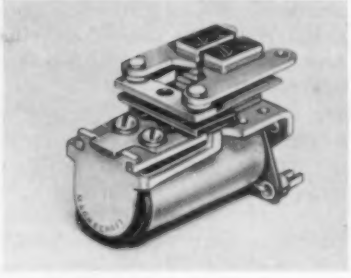
Oil-Hydraulic Reducing Valves

Two low pressure pressure-reducing valves for industrial oil-hydraulic systems are capable of providing any controlled reduced outlet pressure from 25 to 1000 psi. Pressure reducing valves are used in industrial hydraulic systems to provide, for secondary circuits, controlled maximum operating pressure.

Both new valves are for use with $\frac{3}{8}$ in. nominal pipe size in systems

having operating pressures up to 2000 psi. Model XGL-03-B is a gasket-mounted design; Model XTL-03-B is provided with $\frac{3}{8}$ in. pipe thread connections. Vickers Inc., Box 302, Detroit 32, Mich.

For more information—
Circle 41, inside back cover



Small Relay Switches Up to 20 Amp

Double-break contacts that switch up to 20 amp., non-inductive load, are single-pole, single-throw, normally open. Overall dimensions are $2\frac{7}{16}$ x $1\frac{7}{16}$ x $1\frac{7}{16}$ in. wide. Available for operating voltages to 230 v, d-c, and 440 v, 60 cps, a-c. Magnecraft Electric Co., 3350Y W. Grand Ave., Chicago 51, Ill.

For more information—
Circle 42, inside back cover

Backcheck Valve

Designed for use with all hose-attached appliances, this backcheck valve protects home and community water supply systems from pollution

CONTINUED ON PAGE 232

Using

DU PONT ELASTOMERS

NEOPRENE • HYPALON®

in Design

Coatings of HYPALON® add beauty and durability to a variety of products

DuPont's new synthetic rubber, HYPALON, can now be applied as a protective coating on rubber, metal, wood or fabrics. It can be applied by spraying, brushing or spread coating. The development of these coatings, both clear and colored, has opened new avenues of product design in a wide range of applications. Here are the advantages such coatings offer:

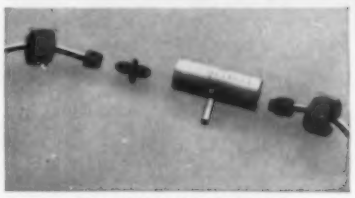
HYPALON is unaffected by ozone. It has unusual resistance to hardening at elevated temperatures (250°-350°F.). It is unique in its resistance to weathering and oxidizing chemicals. And, in addition to the protective benefits of HYPALON coatings, an unlimited range of stable colors is available to add beautiful and functional color to your products.

Applications for HYPALON coatings include tank linings, footwear, tarpaulins, camera bellows, hose, belts and automotive and sporting equipment. For other uses see the photograph below.

How can coatings of HYPALON fit into your design problems? Mail the coupon for more detailed information about your specific problem.

These products feature attractive protective coatings of HYPALON: a piece of corrugated rubber mat (left foreground); a coil of electrical wire, and a child's overshoe on the mat; rubber extrusions for automobile windshield frame and trunk weatherstripping (center foreground); door weatherstripping (right foreground); slab of urethane foam (left rear); basketball (right rear).

NEOPRENE SEALS safeguard fuel line connections in the Douglas DC-7



SEAL READY FOR ASSEMBLY

Safety of passengers is uppermost in the minds of Douglas Aircraft designers—even down to as small an item as the rubber sleeve on a fuel line connector. Douglas uses the best metal connectors to join its fuel lines, but as an additional safety factor the company fits a vapor-tight sleeve seal over each joint which is vented by tubing to the ship's exterior to prevent any possible accumulation of highly flammable gasoline vapors within the fuselage.

Before switching to neoprene, Douglas had a problem with the seals. They required frequent replacement because ozone caused the rubber to crack. In fact, many of the rubber seals were rejected as unusable before installation because of ozone cracks which developed while the pre-assembled units were held in stock.

The installation of neoprene seals proved to be the answer to the problem. Neoprene was chosen because it resists ozone, gasoline, oil and aging. Many of the neoprene seals have been in service for over two years, reducing maintenance and replacement costs.

Perhaps your design problems can be solved by the use of Du Pont neoprene. We'd be glad to send you further information—property data and proven applications. If you have a specific problem, please let us know in the coupon.

NEOPRENE SEALS (in red) resist ozone, oil, gasoline and aging. Many of them have lasted for over 2 years.

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Elastomers Division, Dept. PE-12
Wilmington 98, Delaware

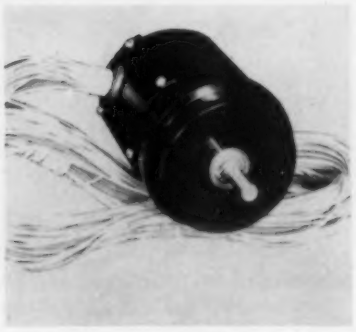
*Firm*_____

*Address*_____

*City*_____ *State*_____

at moments of water pressure failure which create a vacuum, drawing the contents of service pipe lines and appliances back into the storage facilities and/or water mains. The new valve stops this backward flow. The valve is of molded Nylon and, weight for weight, is said to be stronger than steel. It is 2⅛ x 1⅛ in. OD, weighing ⅞ oz. Hercules Plastics Corp., 9 Rockefeller Pl., New York, N. Y.

For more information—
Circle 43, inside back cover



High-Speed Sampling Commutator

This switch provides single-pole sampling of 60 contacts at rates up to 30 rpm. Only 3 in.-oz torque is required. Applied Science Corp. of Princeton, P.O. Box 44, Princeton, N. J.

For more information—
Circle 44, inside back cover

Gear Reducers

These gear reducers cover ratio ranges from 3:1 up to 250:1, by changing the combination of standard planetary assemblies available. Each unit consists of the basic, cast, machine steel housing with one, two or three planetary assemblies as required. All planetaries are interchangeable. Height is 11¾ in.; width, 12 in. Length ranges from 15⅛ to 21⅜ in., depending on number of planetaries. Crichton Co., 1006 U. S. National Bank Bldg., Johnstown, Pa.

For more information—
Circle 45, inside back cover

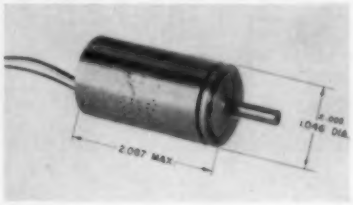
Multi-Voltage Solenoid Valve

Flow control of twelve common fluids through 42 different valve styles and capacities, and with any one of seven electrical circuits (115 v, 25 cps; 115 v, 50 and 60 cps; 208 v, 50 and 60 cps; 230 v, 50 and 60 cps), is now obtainable through the use of a new solenoid coil. Valves range from ⅜ to 1¼ in. port sizes and are suitable for temperatures up to 225 F. Jackes-Evans Mfg. Co., 4427 Geraldine Ave., St. Louis 15, Mo.

For more information—
Circle 46, inside back cover

Variable Frequency Blower Motor

A single-phase, four-pole, variable frequency blower motor which is said to maintain a fairly constant speed over a wide frequency range through the use of two external capacitors is now available. With a 2 in. blade fan and frequencies between 400 and 1800 cps, speed is between 7800 and 11,000 rpm. With a 3 in. blade fan, frequencies between 300 and 1000 cps, speed is between 4400 and 5200 rpm.



Excitation is 115 v, continuous duty, and operating ambient temperature range −54 C to 70 C. Maximum length is 2.015 in., 1.046 in. OD; weight 5 oz. John Oster Mfg. Co., Avionic Div., Racine, Wis.

For more information—
Circle 47, inside back cover

Supersensitive Meter Relays

Operating on power inputs of less than 50 millimicrowatt, the relays will control up to 1 w. They are a nonlocking type, currently available in 2 in., d-c and 3 in. a-c and d-c models as microammeters, milliammeters, ammeters, millivoltmeters and voltmeters. Simpson Electric Co., 5200 W. Kinzie St., Chicago 44, Ill.

For more information—
Circle 48, inside back cover

Pressure Gage Protector

The gage protector is designed to automatically cut out the gage when line pressure rises above a specific spring setting. The unit has an external pressure adjusting control. Constructed with brass corrosion-resistant

CONTINUED ON PAGE 234

Users of tubing for cylinder applications now you can have this new...

J&L Cold Drawn ELECTRICWELD

Tubing with a Special Smooth ID Finish

Reduces your overall production costs in applications like these . . .

- **cylinder tubing**
- **hydraulic and pressure tubing**
- **shock absorbers**
- **ordnance components**

This new drawn-over-mandrel grade tubing with its mirror-like inside surface finish is today busy helping manufacturers reduce or entirely eliminate costly machining on many applications and is being substituted for more costly types of steel tubing. For example, it may be used, without inside honing, for many cylinders through which plungers are passed.

J&L Cold Drawn ELECTRICWELD Tubing with a *Special Smooth* ID finish combines the physical advantages imparted by today's modern electric welding techniques with those of cold working. It withstands high internal hydrostatic pressures, carries heavy torsion loads, resists high-frequency vibration, and offers a favorable weight-to-strength ratio for applications in which loading occurs in all directions.

J&L Cold Drawn ELECTRICWELD Tubing can be furnished in its three specifications in OD sizes from ½ inch to 2⅝ inches and in wall thickness from 20 to 10 gage, 0.035 and 0.134 inch respectively.

This new booklet provides the information you need . . . specifications . . . tolerances . . . chemistry . . . mechanical properties . . . annealing . . . finishes.

Send for your free copy today!

J&L STEEL

Jones & Laughlin Steel Corporation
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Send me a copy of your new Cold Drawn ELECTRICWELD Booklet.

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DPS POWER SCREWDRIVERS and other Assembling Equipment

Present Owners Report a SHARP GAIN in OUTPUT and a RISE in PROFITS!

Important Reasons why you, too, should benefit from greatly stepped-up, lower-cost production and the wider profit margin that naturally follows . . . These 2-way advantages of DPS Power Methods have been proved in over a quarter century of service to modern industry . . . If you are still using out-moded assembling methods, change now . . . Get the facts about the extensive DPS line. No doubt we have a product that can be adapted to your requirements. Write today.

BARREL FEEDER
with stationary ring cover, for heavy-duty, large production runs

BOWL FEEDER
Vibratory type, to select and feed smaller fragile parts

DPS SELECTIVE PARTS FEEDERS

Modern Necessities Widely Adaptable

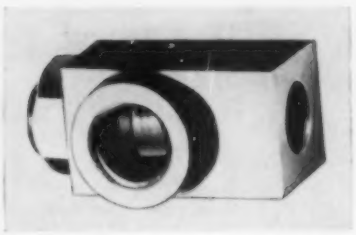
These versatile devices not only provide the feeding operations on Detroit Power Screwdrivers, but they are being widely used on today's many special high-production machines.

5 SCREW-DRIVING MACHINES
Bench and Pedestal types. Pedestal Model A pictured

WHAT IS YOUR FEEDING AND ASSEMBLING PROBLEM? WRITE US—ALSO SEND SAMPLE ASSEMBLY

DETROIT POWER SCREWDRIVER CO.

2821-A W. FORT ST. DETROIT 16, MICHIGAN



bodies for oil or gas service, the protectors are available with port connections up to ½ in. Superior Hydraulics Div., 15201 St. Clair Ave., Cleveland 10, Ohio.

For more information—
Circle 49, inside back cover

Teflon Hose Assemblies

The assembly consists of a Teflon liner encased in stainless steel wire braid with fittings permanently locked to the hose. The units are capable of sustained operating pressures up to 400 psi at −100 to 500 F. Eight sizes are currently available from stock, ranging from ⅜ to 1¼ in., with a maximum length of 50 ft. Mic-Lin Co., Route 38 at Rudderow Ave., Maple Shade, N. J.

For more information—
Circle 50, inside back cover

Bar Knobs

These four-pronged knobs are made of malleable iron and are easily turned by hand or with a bar or tool handle inserted between the prongs. Four

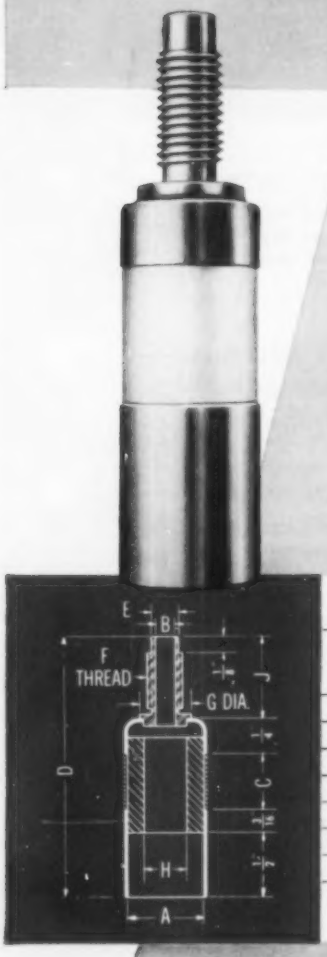
(Continued on page 238)

RUGGEDIZED *ADVAC*

CABLE END SEALS

- Provide Permanent Hermetic Sealing
- Terminal Assembly Complies with MIL-T-27 Requirements
- Withstand Temperatures to 1400°F and Pressures to 2000 P.S.I.

HIGH TEMPERATURE HERMETIC SEALS FOR METALLIC SHEATHED CABLES, HEATING ELEMENTS AND OTHER TUBULAR COMPONENTS



The ADVAC metallizing process applied to Hi-Alumina Ceramic produces super rugged hermetic seals. These standard cable end seals operate over extreme excursions of temperature, humidity, shock and vibration. The metal portions provide the ultimate in corrosion resistance and are easily bonded to associated equipment by brazing at temperatures up to 850°C.

For complete information on ADVAC End Seals or Seals for other applications, call or write today!

DIMENSIONS

TYPE	A	B	C	D	E	F	G	H	J	Operating Voltage*	Current Rating	Terminal Torque Rating†
250-ES	.250	.082	5/16	1-11/16	.125	8-32	1/4	1/8	7/16	1000	20 A.	15
320-ES	.320	.113	5/16	1-15/16	.148	10-32	1/4	5/32	11/16	1500	30 A.	20
330-ES	.330	.116	1/2	1-7/8	.148	10-32	1/4	5/32	7/16	1500	30 A.	20
375-ES	.375	.116	1/2	1-7/8	.148	10-32	1/4	3/16	7/16	2500	30 A.	20
450-ES	.450	.150	1/2	2-1/8	.203	¼-28	3/8	1/4	11/16	2500	60 A.	35
500-ES	.500	.150	1/2	2-1/8	.203	¼-28	3/8	1/4	11/16	2500	60 A.	35
625-ES	.625	.150	1/2	2-1/8	.203	¼-28	3/8	5/16	11/16	2500	60 A.	35

*40% R.H. – sea level – 60 cycles R.M.S. per MIL-T-27 Test Method.
†Rated maximum terminal rotational torque in inch lbs.

DIVISION OF GENERAL CERAMICS CORPORATION

ADVANCED VACUUM PRODUCTS · INC

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Polyurethane (polyester-isocyanate); polyvinyl chloride; polystyrene; epoxies; phenolics; etc.

Cellophane; cellulose acetate; cellulose acetate butyrate; cellulose nitrate; Mylar; Pliofilm; polyethylene; polyvinyl alcohol; polystyrene; Saran; vinyl; etc., and all foils.

If you will give us the details of the adhesive problems you face, chances are we can show you a case history of a similar production problem that has been successfully solved with one of the more than 650 current "BOND-MASTER" adhesives.

And if yours is truly "special", our extensive laboratories backed by more than 43 years of experience in the exclusive manufacture of industrial adhesives can probably "custom build" a formulation to answer your specific needs.

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Here is the information your adhesive supplier must analyze in order to successfully solve YOUR ADHESIVES PROBLEM:

WHICH MATERIALS

Which plastics? Which metals? Which rubbers? Which fibres? Porous or non-porous? How thick?

TYPE OF APPLICATION

Brush? Knife? Spray? Dip? Roller? Extrusion? Other?

PHYSICAL PROPERTIES

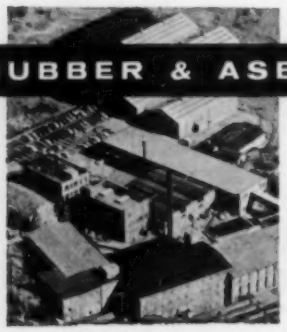
Maximum and minimum viscosity? Preferred drying time? Maximum drying temperature? Required tack time? Required pot life? Required vulcanizing conditions? Any pressure conditions?

SERVICE REQUIREMENTS

Bond strength (shear? peel? impact?) Film color? Flexibility? Toxicity? Stability? Odor? Government Specifications?

SERVICE CONDITIONS

Resistance to temperature? Which solvents? Which chemicals? Sunlight? Water? Cold? Heat (how much? how often?) Abrasion?



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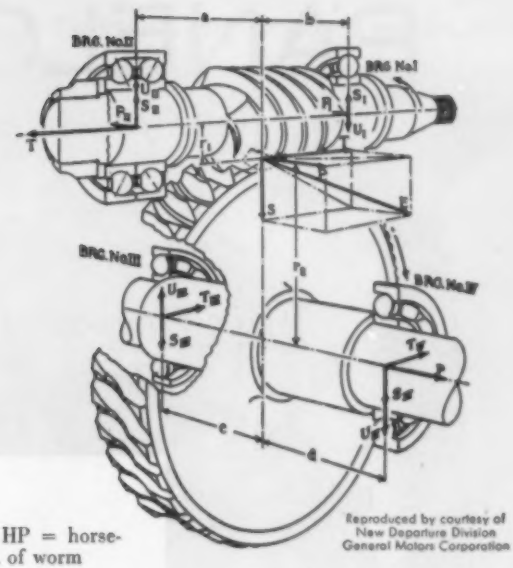
Helpful Data from DE LAVAL

How to Calculate Worm Gear Bearing Loads



Reproduced by courtesy of New Departure Division General Motors Corporation

$Q = \frac{HP \times 63025}{N}$ = TORQUE INPUT to worm, lbs. inches; HP = horsepower transmitted and N = rev. per min. of worm

$P = \frac{Q}{r_1}$ = TANGENTIAL FORCE of worm, where

r_1 = Pitch radius of worm in inches

[r_2 = Pitch radius of worm gear

$= \frac{1}{2\pi}$ (number of teeth in gear x axial worm pitch)]

$S = \frac{P \tan \alpha}{\tan \gamma}$ = SEPARATING FORCE, where

α = Axial tooth pressure angle*

γ = Helix or lead angle of worm*

$= \tan^{-1} \frac{\text{lead}}{2\pi r_1}$, or $\tan^{-1} \frac{\text{Number of threads x axial worm pitch}}{2\pi r_1}$

$T = \frac{P}{\tan \gamma}$ = WORM THRUST, or tangent force driving worm gear

* LEAD ANGLE 0°-35° use 27½° Pressure Angle
LEAD ANGLE 35°-45° use 30° Pressure Angle

BEARING LOADS

Due to	on Brg. I	on Brg. II
P	$P \frac{a}{a+b} = P_I$	$P \frac{b}{a+b} = P_{II}$
S	$S \frac{a}{a+b} = S_I$	$S \frac{b}{a+b} = S_{II}$
T	$T \frac{r_1}{a+b} = U_I$	$T \frac{r_1}{a+b} = U_{II} = U_I$
Total Rad. Load	$\sqrt{P_I^2 + (S_I - U_I)^2}$	$\sqrt{P_{II}^2 + (S_{II} + U_{II})^2} = R_{II}$
Thrust Load		T
Total Load	$\sqrt{P_I^2 + (S_I - U_I)^2}$	$\sqrt{R_{II}^2 + T^2}$

Due to	on Brg. III	on Brg. IV
P	$P \frac{r_2}{c+d} = U_{III}$	$P \frac{r_2}{c+d} = U_{IV} = U_{III}$
S	$S \frac{d}{c+d} = S_{III}$	$S \frac{c}{c+d} = S_{IV}$
T	$T \frac{d}{c+d} = T_{III}$	$T \frac{c}{c+d} = T_{IV}$
Total Rad. Load	$\sqrt{T_{III}^2 + (U_{III} - S_{III})^2}$	$\sqrt{T_{IV}^2 + (S_{IV} + U_{IV})^2} = R_{IV}$
Thrust Load		P
Total Load	$\sqrt{T_{III}^2 + (U_{III} - S_{III})^2}$	$\sqrt{R_{IV}^2 + P^2}$

Speed Change

$$\text{Gear rpm} = N \times \frac{\text{Number of threads in worm}}{\text{Number of teeth in gear}}$$

For simplicity in bearing load computations for worm gearing, the normal tooth force E is treated in terms of its three perpendicular elements, namely, P, the tangential driving force at pitch radius of worm; S, the force tending to separate worm from the gear, due to the pressure angle; and T, the thrust produced by the lead or helix angle of the worm.

If you have a problem in the selection or application of worm gearing, De Laval engineers will be glad to put their experience to work for you. Either write us giving complete details, or consult your local De Laval representative. De Laval Steam Turbine Company, 801 Nottingham Way, Trenton 2, New Jersey

DL 948

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Curtiss-Wright

Turbo Compound engines!

Here's why Curtiss-Wright engineers choose PANELOC.

STRENGTH-WEIGHT RATIO! The strength of PANELOC Panel Fasteners is so far in excess of requirements of governing specifications that fewer fasteners are required to do a particular job. This saves the weight of extra fasteners.

LONG LIFE! PANELOC Panel Fasteners are still operative when baffles and ducts wear out. Maintenance is thereby reduced to a minimum. The need for replacements is virtually eliminated.

ECONOMY! The cost of extra fasteners is eliminated and the cost of installation and maintenance reduced when PANELOC Panel Fasteners are used.

Write for catalogues and price lists on Styles 1, 2 and 3 Panel Fasteners.

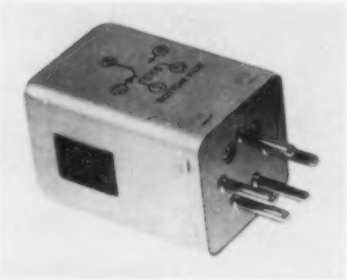
A product of SCOVILL

Scovill Manufacturing Company, Aircraft Fastener Div.
49 Mill Street, Waterbury 20, Connecticut

models have extra long prongs for use with crank handle. Complete range of fifteen models provides sizes for every requirement. Screw threads are precision machined.

Bar knobs can be used to hold down covers and clamp heavy work pieces and, also, as a component in the construction of various types of jigs and fixtures and on some types of metal-working machines. Jergens Tool Specialty Co., 712 E. 163 St., Cleveland 10, Ohio.

For more information—
Circle 51, inside back cover



Photoelectric Relay

A photoelectric control uses a cadmium sulfide photocell and relay, mounted on a five-pin plug-in base and housed in a dust can measuring 1½ x 2¼ in. high. The relay operates at 5 ft-c or less, releases at 0.1 ft-c or more, at a guaranteed speed of two operations per second. Supply voltage is 115 v a-c, 50/60 cps, and temperature range is −40 C to 75 C. Sigma Instruments, Inc., 59 Pearl St., S. Braintree, Boston 85, Mass.

For more information—
Circle 52, inside back cover

Silicon 10-Kw Rectifiers

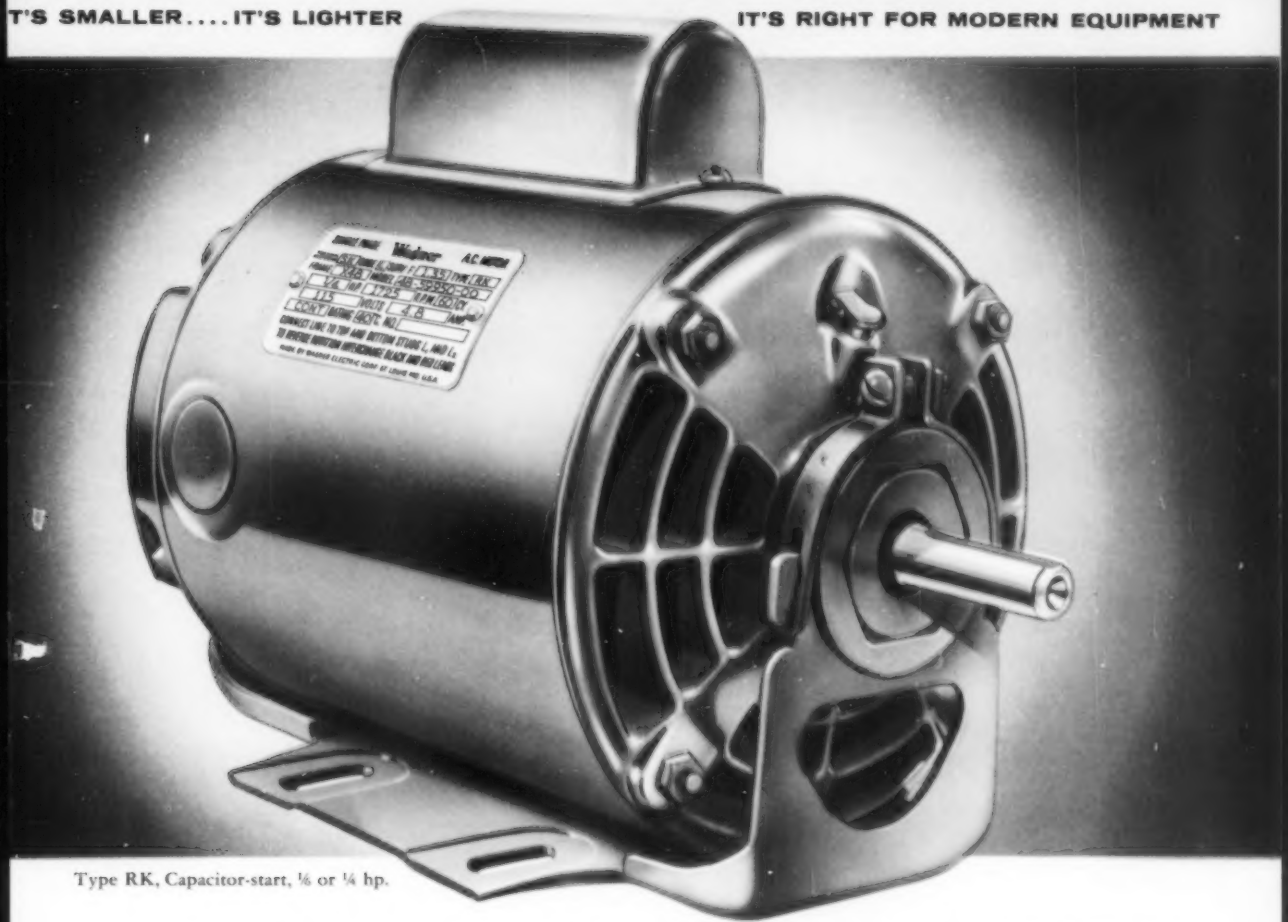
The rectifiers are capable of operation in temperature range of −65 C to 200 C. Combinations of the rectifiers will allow power output ratings of 1000 kw and above, according to the maker.

Some of the applications for the new series include jet and propeller driven aircraft power supplies; locomotive propulsion motors; on-the-spot conversion of a-c to d-c for d-c motor drives.

The four new rectifiers are available in peak inverse voltage ratings of 50,

(Continued on page 241)

T'S SMALLER....IT'S LIGHTER IT'S RIGHT FOR MODERN EQUIPMENT



Type RK, Capacitor-start, ⅛ or ¼ hp.

the WAGNER "48"

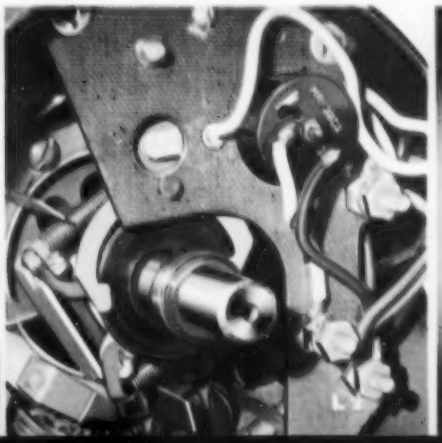
new fractional horsepower motor

Here's the 48 frame motor you've been looking for! The Wagner "48" comes with either resilient or rigid base ... capacitor-start or split-phase type. You get the standard 48 frame size—with from *three* to *eight* pounds less weight per motor than previous models in the same hp ratings! The Wagner "48" is easier to handle... to stock... to install. Yet it's packed with Wagner quality—a known value for more than 65 years.

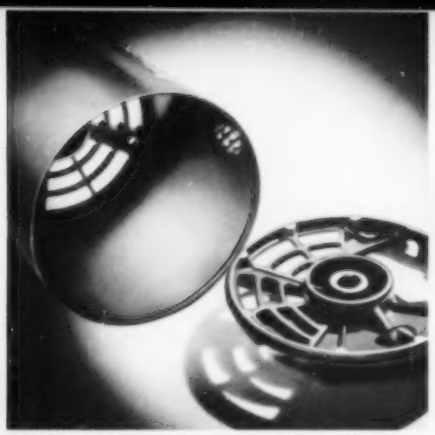
MYLAR*-PAPER LAMINATED SLOT INSULATION combines top moisture resistance with high dielectric strength and thermal stability—gives the Wagner "48" more application versatility, longer life, when unexpected overloads occur. *DuPont trade mark.

QUICK BREAK SWITCH, that disconnects the starting winding and capacitor from the line at a predetermined speed, makes and breaks with minimum arcing —is dependable and trouble-free.

BABBITT LINED BEARINGS give *smooth* performance. They stand heavy pressures with low temperature rise, have superior anti-seizure and non-scoring characteristics, are corrosion-resistant.



ALL ANGLE OPERATION. You can mount the Wagner "48" at any angle. A new lubrication system assures positive protective lubrication in any position.



LIGHT WEIGHT STEEL FRAME, precision-machined for accurate endplate fit, combined with CAST ALUMINUM ENDPLATES, gives the "48" strength with light weight.

EASY TO CONNECT. Just loosen one screw for access to terminal board. **EASY TO SERVICE** . . . no need to disconnect leads when removing endplates.

solves problems for the design engineer

For design engineers who've been looking for light weight, fractional horsepower motors with less bulk—here's good news!

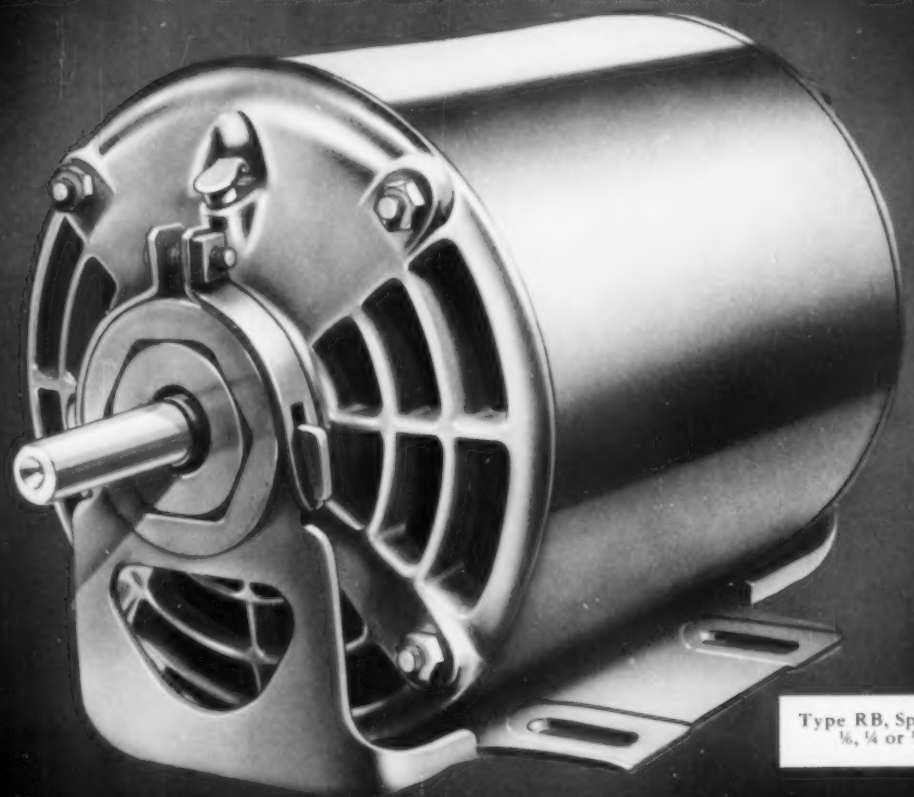
Wagner "48" capacitor-start or split-phase motors are rugged enough to permit direct mounting, are compact enough to fit in tight spots, are exceptionally light in weight, and operate efficiently when mounted at any angle. Both types are available with resilient bases or with rigid bases that are *welded* to the steel motor frames to provide great strength. Through ventilation assures cool running motors that last longer.

If you would like to test the new Wagner "48," one of our field engineers will be glad to furnish a sample motor. Contact the Wagner Branch near you or write us.

WAGNER ELECTRIC CORPORATION . . . 6400 Plymouth Avenue, St. Louis 14, Missouri

M56-1

the WAGNER "48"



Type RB, Split-phase, ⅙, ¼ or ⅓ hp.

100, 200 and 300 v with rms voltage ratings of 35, 70, 140 and 210 v. Maximum reverse current rating is 50 milliamp at maximum peak inverse ratings at 200 C junction temperature. Leakage current of less than 1/1000 the forward current contributes to high efficiency ratings of the new rectifiers. Maximum allowable one cycle surge current rating is 900 amp and the maximum allowable continuous current is 84 amp per cell. General Electric Co., Syracuse, N. Y.

For more information—
Circle 53, inside back cover

High Impact Liquid Spring

This unit provides a 10,000 lb spring with a 1000 lb preload and an integral heavy duty shock absorber, which together absorbs 22,500 in.-lb

(Continued on page 244)

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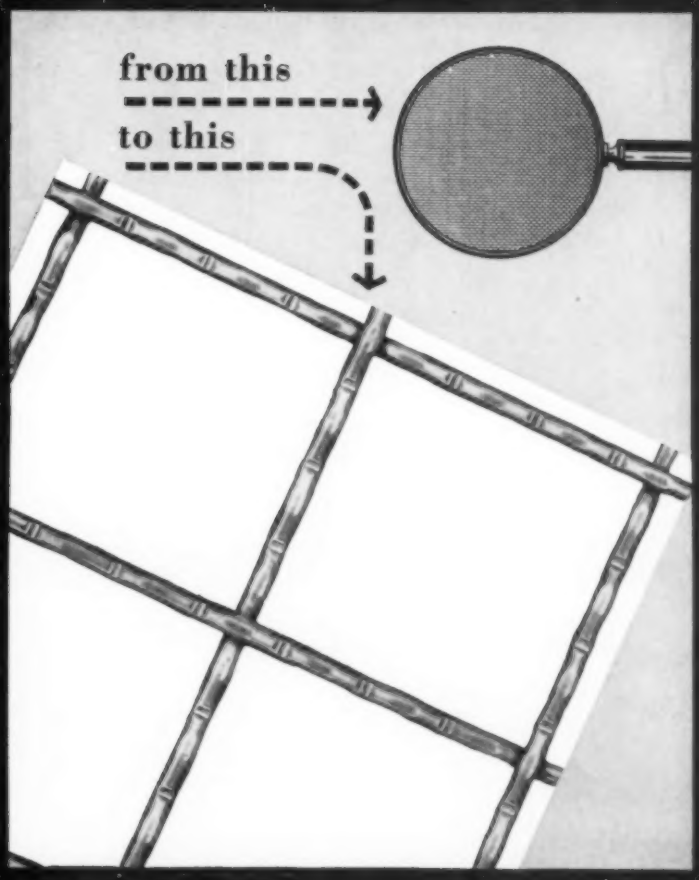

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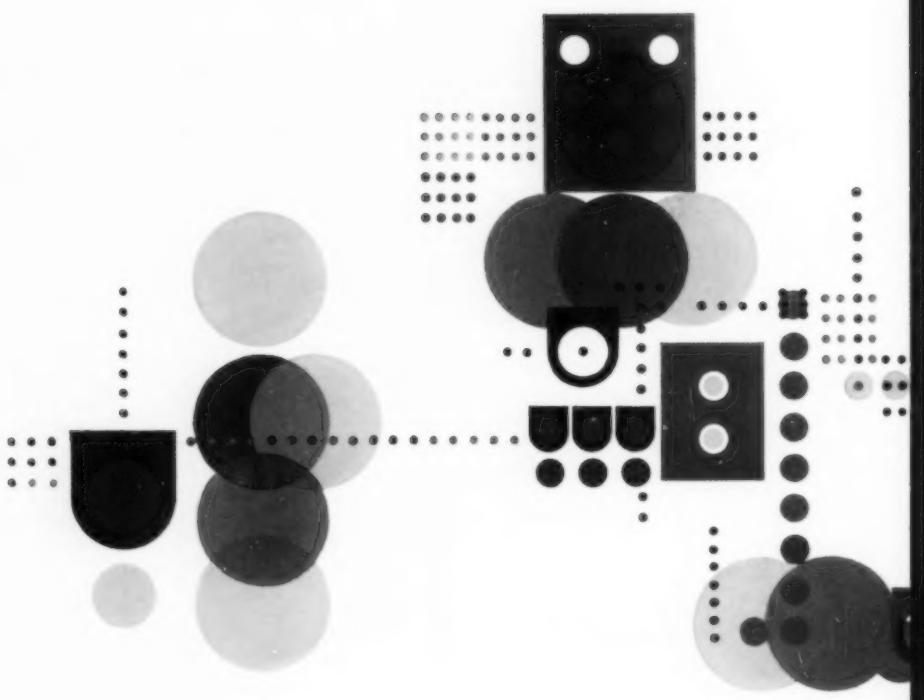
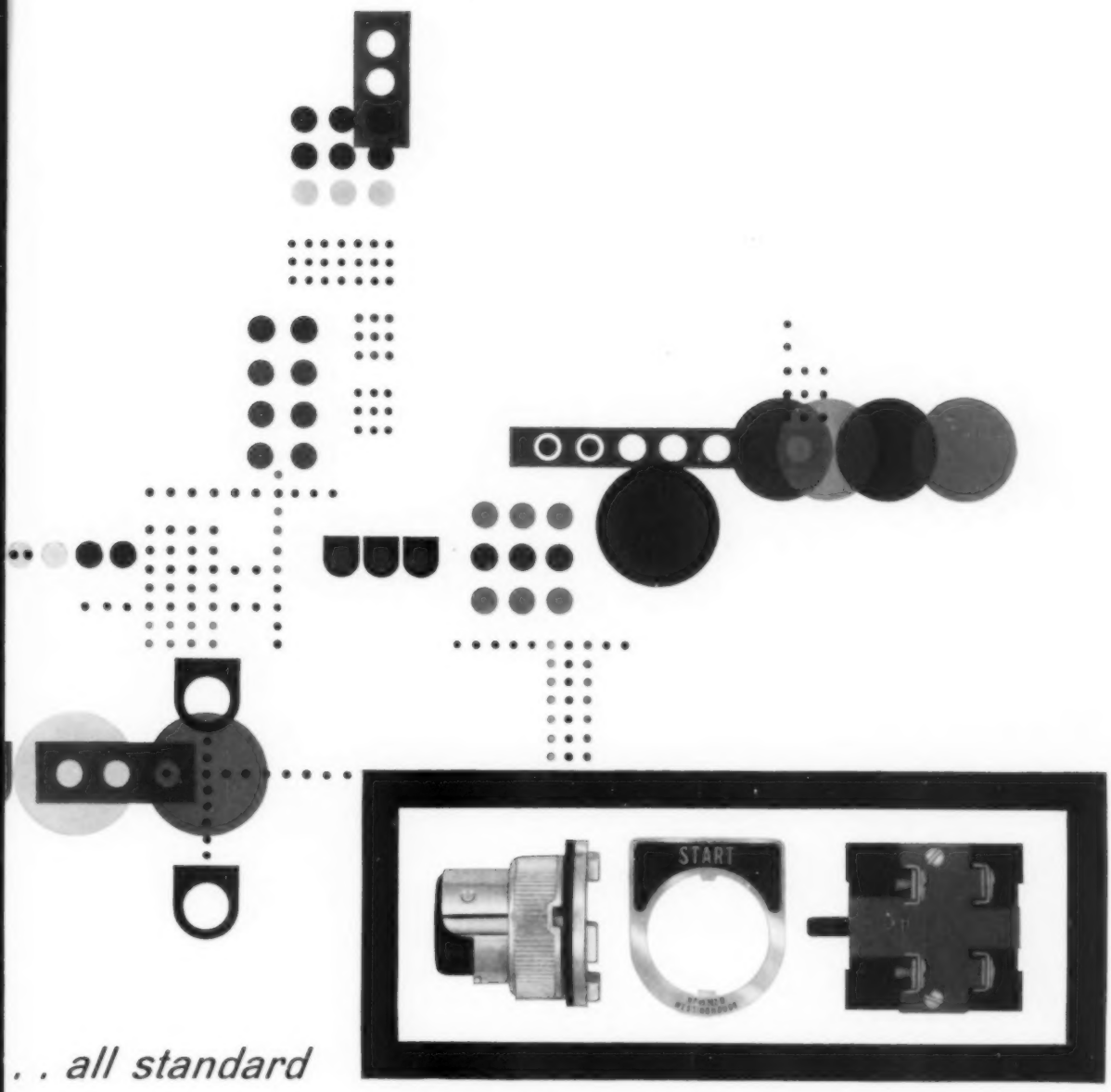


Pushbutton control arrangements almost to infinity .



. . all standard

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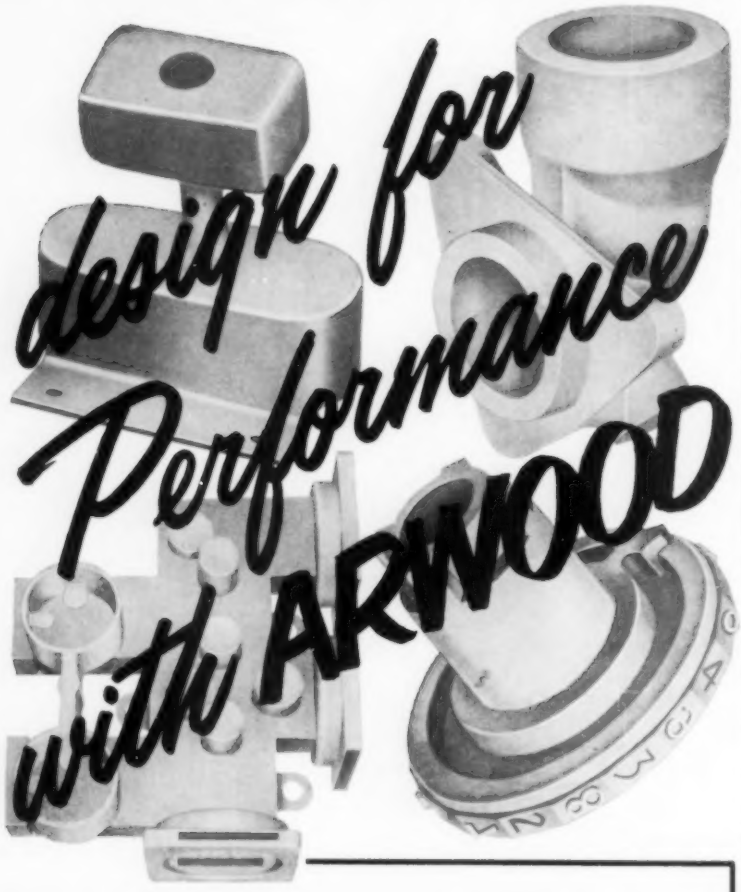
If you need controls for any application, write for the free 72-page *Pushbutton Guide*, B-6749. For control where moisture is a problem, write for free Booklet, B-7022, about Oil-Tite* controls. Write to Westinghouse Electric Corporation, Box 868, Pittsburgh 30, Pa. Or call your Westinghouse Distributor.
*T. M.

J-30248

YOU CAN BE SURE... IF IT'S

Westinghouse



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of energy at a velocity of 360 ips. This assembly is designed to cushion the impact of a 10,000 lb mass moving into a mechanical stop which it resiliently supports without damage to the finished product. Dimensions are 3½ x 14 in. long, excluding trunnions. Taylor Devices Inc., 188 Main St., N. Tonawanda, N. Y.

For more information—
Circle 54, inside back cover

Non-Sticking Rubber Compound

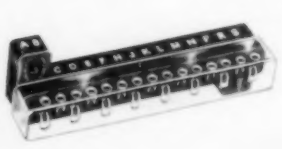
A rubber compound has non-sticking properties, making it ideal for valve seat and other applications. The material gives quick break-away without lubrication. Recommended temperature range is from —40 F to 300 F. It has excellent bonding-to-metal properties, the manufacturer reports. Goshen Rubber Co., Inc., Goshen, Ind.

For more information—
Circle 55, inside back cover

Epoxy-Tar Coatings

Epoxy-tar coatings with solids content ranging from 85 to 90 per cent are said to show excellent resistance to water, high relative humidity, brine, refinery products, ultra violet light, hydrogen-sulfide gases and ammonia as well as other acids, salts and alkalies. Carboline Co., 331 Thornton Ave., St. Louis 19, Mo.

For more information—
Circle 56, inside back cover



Printed Circuit Connector

Coded contacts (15) are mounted in Orlon-filled diallyl phthalate molding compound. Design permits either horizontal or vertical mounting. A potting shell is supplied with the connector. Wiring feeds through

(Continued on page 248)

WICHITA Air-Tube CLUTCHES The Best Choice . . .

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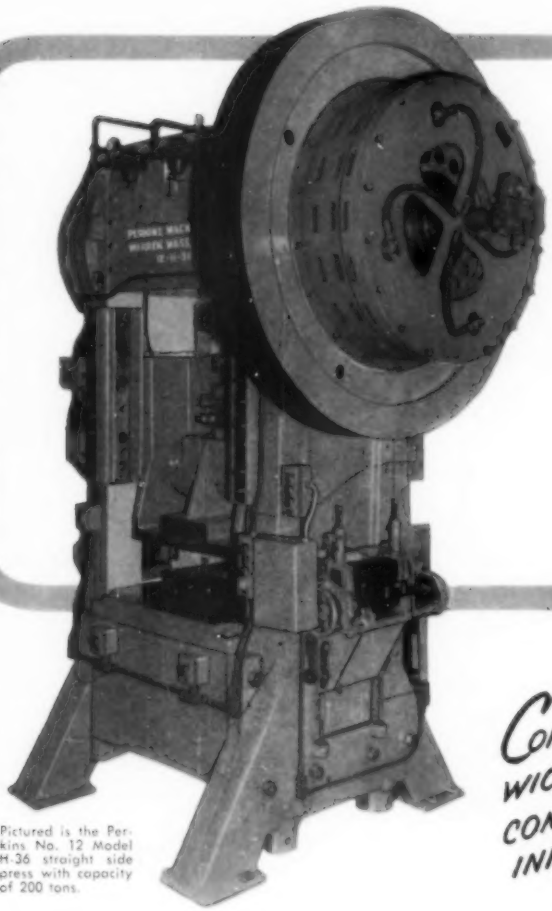

Pictured is the Perkins No. 12 Model H-36 straight side press with capacity of 200 tons.

—Perkins Machine Company
Warren, Mass.

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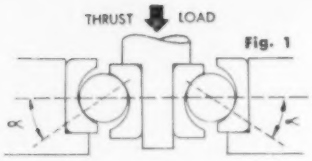
Industrial Air Controls Co., Fort Worth, Texas
Allied Transmission Equipment Co., Kansas City 8, Missouri

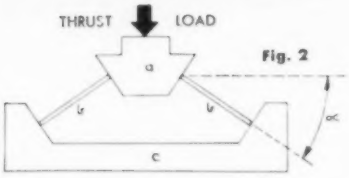
WICHITA Clutch COMPANY, INC.
WICHITA FALLS, TEXAS, U.S.A.

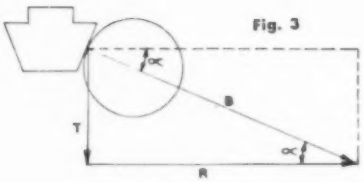
ENGINEERING BULLETIN
ON MICRO-BEARINGS
Miniature Instrument Ball Bearings

NEW HAMPSHIRE BALL BEARINGS, INC.
PETERBOROUGH 1, NEW HAMPSHIRE

Subject: CONTACT ANGLE







THRUST LOAD CONSIDERATIONS

Contact angle is the angle between a plane perpendicular to the bearing axis and a line connecting the two points on a given ball where the ball makes contact with the raceways when the bearing is subjected to a pure thrust load. In *Fig. 1*, the contact angle is represented by angle α. The significance of the contact angle is revealed by an examination of the forces present in a thrust loaded bearing.

In *Fig. 2*, a simplified version of *Fig. 1*, the shaft and inner ring combination are represented by the plug *a*, the "working diameters" of the balls are represented by the rodlike members at *b*, and the outer ring is represented by the tapered cup *c*.

The contact angle is α. This diagram represents a three-dimensional structure with as many equally spaced rods, *b*, as there are balls in the bearing.

The primary concern in design is the amount of compressive force to which rod *b* is subject, which is the force with which a given ball is pressed against the raceways. This force can be calculated by constructing a parallelogram of forces as shown in *Fig. 3*.

The sides T and R, are vector quantities, and diagonal B is the vector sum of T and R. Furthermore, the vector sum of the thrust components on all the balls equals the total thrust load on the bearing. The vector sum of the radial components on all the balls is zero. Vector B, the force actually felt by the raceways and balls, compared to vector T, the thrust component, varies significantly with changes in the size of the contact angle and is directly proportional to the thrust load component and inversely proportional to the sine of the contact angle.

Example I:

A bearing is carrying a pure thrust load of 21 pounds. Assuming seven balls in the bearing, each ball will have an axial load component of three pounds, since a thrust load is shared equally by all the balls. While the axial component on each ball is only three pounds, the actual compressive force, or squeeze, felt by the ball and raceways is considerably greater than this value.

With a contact angle of five degrees:

$$B = \frac{T}{\sin \alpha} = \frac{3 \text{ pounds}}{\sin 5^\circ} = 34.5 \text{ pounds}$$

Thus we see that with a five-degree contact angle the actual load felt by each individual ball is actually considerably greater than the total 21 pound thrust load on the bearing.

Example II:

Using the thrust conditions in Example I, the contact angle is increased to 20 degrees, by selecting a bearing with a larger value of radial play.

$$B = \frac{3 \text{ pounds}}{\sin 20^\circ} = 8.78 \text{ pounds}$$

A 15 degree increase in contact angle produced a 74.5% reduction in ball-to-raceway contact stress. This relationship should be noted by anyone who writes bearing specifications. The operational qualities of the bearing, such as low running and starting torque and bearing life, are a function of the ball-to-raceway contact stress. Thus the contact angle is highly significant.

It is not necessary for a bearing user to calculate or specify the contact angle desired. It is only necessary to remember that low values of contact angle are associated with low radial play, and high values of contact angle are associated with high radial play.

While the advantages of large contact angle have been examined above in some detail, there is one important factor which, in high speed applications, places a restriction on the magnitude of contact angle for optimum bearing performance. This is the matter of gyratory forces on the balls. Each ball in a bearing may be visualized as a little planet rotating on an orbit represented by the pitch circle of the bearing, while at the same time rotating about an axis of its own. It is this latter mode of rotation which concerns us at the moment. Every rotating body exhibits gyroscopic characteristics which vary in magnitude with the speed of rotation. Most important of these characteristics is the reaction of the rotating body to changes in the direction of its axis. Now the axis of rotation of a ball in a bearing is represented by a line which passed through the center of the ball and which is perpendicular to the line connecting the points of contact with the raceway. This means that the angle between the axis of ball rotation and the axis of the bearing is equal to the contact angle *(see Fig. 4)*.

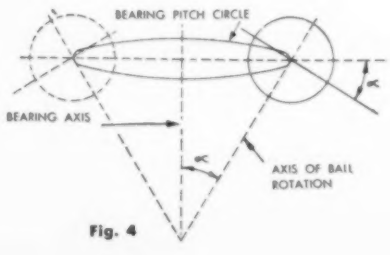


Fig. 4

As the ball travels around its pitch diameter orbit, the axis of ball rotation is forced to change constantly. Specifically, the gyratory moment acting on a ball is proportional to, among other factors, the sine of the contact angle. Thus as the rotational speed is increased, a point will be reached where the gyratory forces acting on the balls will produce slippage between the balls and the raceways. This induces increased operating temperature as well as premature bearing failure.

Thus in high speed applications, optimum bearing performance is a compromise between high contact angle for minimum ball-to-raceway stress, and low contact angle for minimum slippage between balls and raceways.

RADIAL LOAD CONSIDERATIONS

With a pure radial load, the load at any instant is not shared equally by all the balls as in the case of thrust loading, but is supported by three or four balls at most. The higher the radial play, the greater is the tendency for the load to be concentrated on one or two balls; while the lower the radial play, the more the load is apt to be distributed on three or four balls. This more even distribution of load in radially loaded bearings with low radial play is reflected in reduced torque and extended bearing life.

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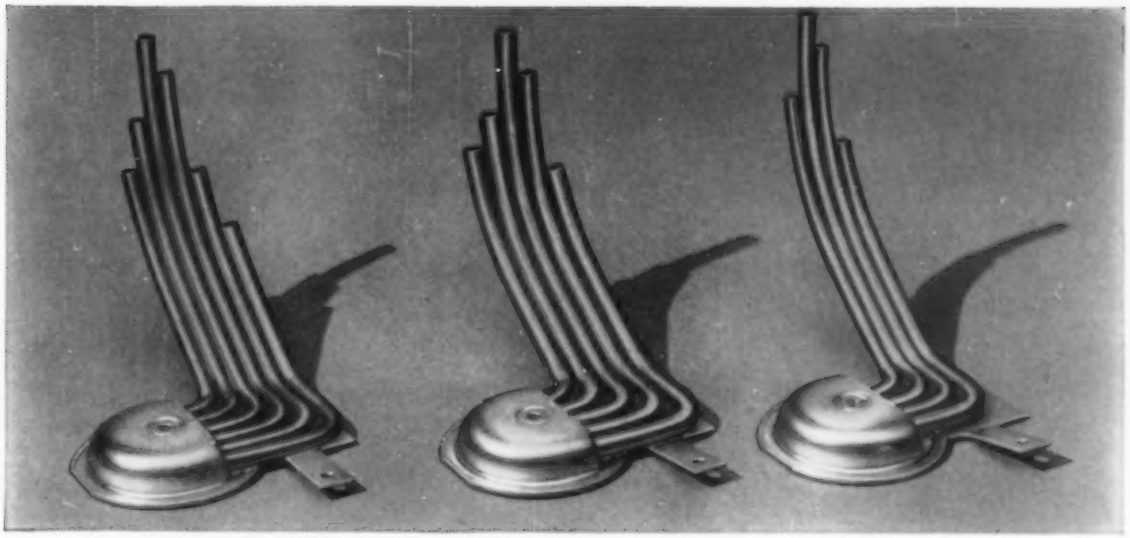

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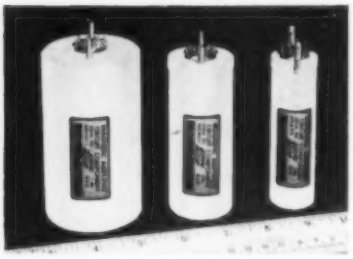
holes in potting shell, which line up with right angle solder lugs. In assembly of printed circuit, a rubber boot fits over the printed circuit board to form an integrated, moisture-proof assembly. DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.

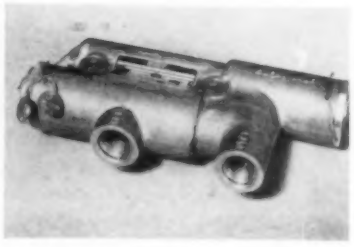
For more information—
Circle 57, inside back cover



Magnetic Amplifiers

These completely self-contained circuit components are available up to 300 w capacity. The largest unit, rated at 300 w at 400 cps, measures 4⅛ x 2⅛ in. dia. Adler Electronics, Inc., 1 LeFevre Lane, New Rochelle, N. Y.

For more information—
Circle 58, inside back cover



Oil-Hydraulic Pressure Control Block

The unit consists of a flow-sensitive pressure regulator valve, a system relief valve and a check valve, all combined within a single housing. The package is designed for use in aircraft auxiliary drive systems where it is desired to reduce starting torque, prevent stalling and purge air from the hydraulic system. Its use insures that the system will be provided at all times with as much pressure as the prime mover is capable of generating without stalling.

Weight is approximately 2.5 lb.

(Continued on page 251)

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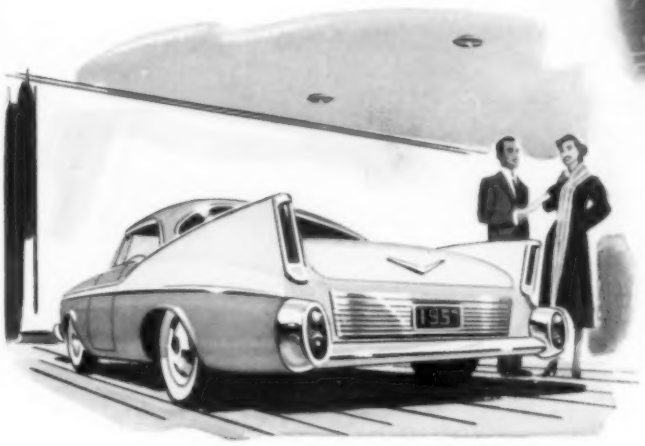

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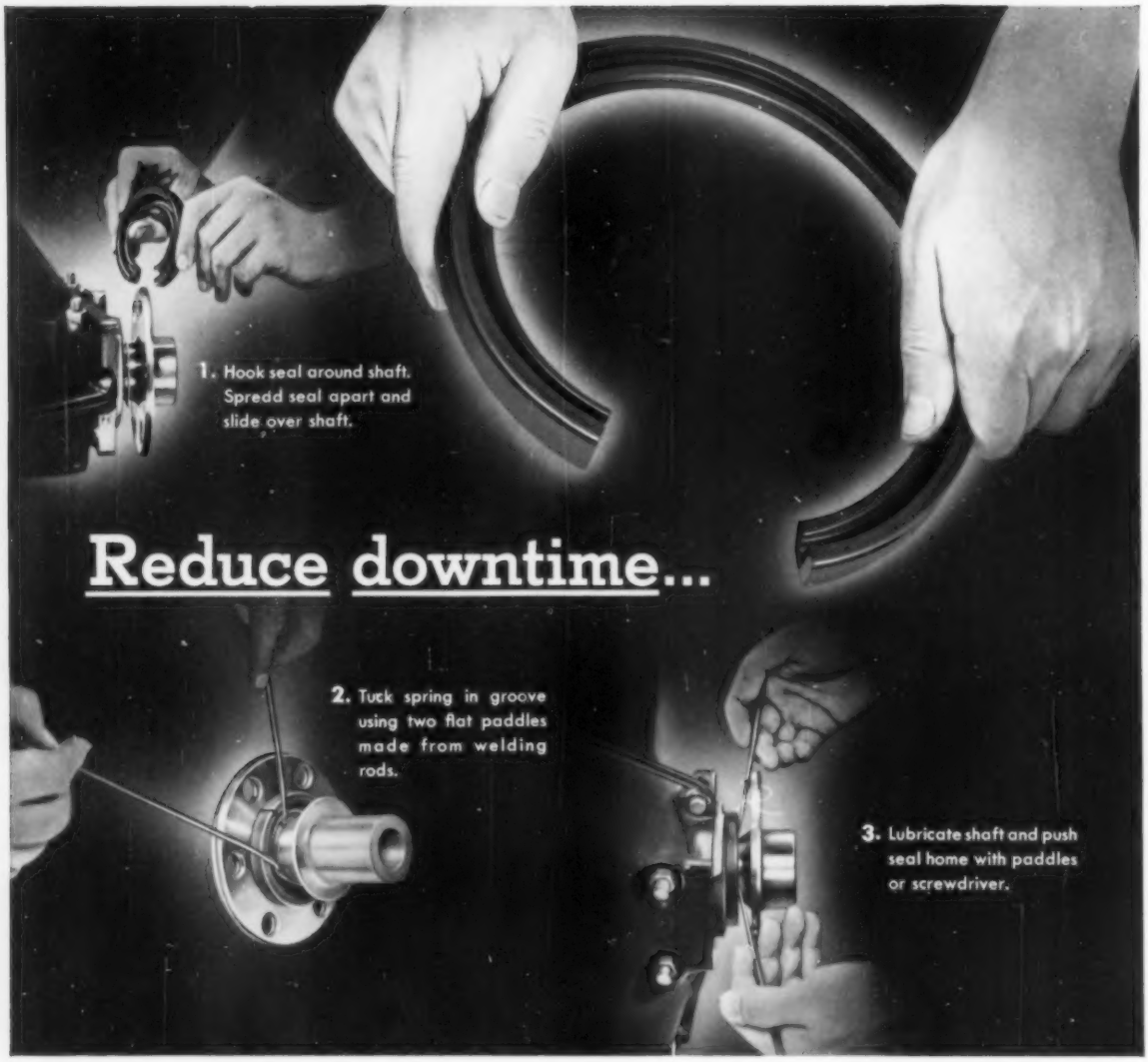

1. Hook seal around shaft. Spredd seal apart and slide over shaft.
Reduce downtime...
2. Tuck spring in groove using two flat paddles made from welding rods.
3. Lubricate shaft and push seal home with paddles or screwdriver.

How J-M Split Clipper Seals speed installation

. . . flexible body provides easy installation and removal even with small clearances

"Downtime" is measured in seconds when Clipper Seals do your sealing. Furnished in split form and made from a highly flexible synthetic rubber compound, they can be readily slipped into the tightest spots. Neither special training nor special tools are required . . . no drilling and tapping for cover plates is necessary because cover plates are not needed.

Clipper Seals are virtually fracture-proof and stand up well under rough handling by inexperienced mechanics. The self-adjusting garter spring has a hook and eye which is easily hooked around the shaft. It is then a simple procedure to slip it into the groove. When the shaft end is accessible, solid seals are used and snap into place almost as quickly as you can say "Clipper Seal." What's more, they stay put.

Reduced "downtime" is only one of many advantages you get with J-M Clipper Seals. Precision moulded from a variety of corrosion-resistant compounds specially developed for each service, they provide maximum sealing ability, low torque, long life and wide adaptability. For more information on the complete line of Clipper Seals, write for new 28-page illustrated brochure PK-71A. Address Johns-Manville, Box 14, New York 16, New York. In Canada, Port Credit, Ontario.

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville CLIPPER SEALS

The block has been qualified for use at temperatures from −65 F to 275 F. Recommended nominal operating pressure is 3000 psi. Vickers Inc., Box 302, Detroit 32, Mich.

For more information—
Circle 59, inside back cover

Shaft-Mounted Gear Motor

A shaft-mounted gear motor designed to provide remote and automatic control for variable speed drives, valves, pumps, feeders and other machines, mounts on shafts from ¼ to ⅞ in. dia. Both housing and cover are made of aluminum. It is furnished with a torque arm or torque plate with resilient mounting that absorbs any runout that may be present in the shaft to be controlled.

Speeds from ½ rpm to several hundred can be had from the standard units. Torques from a few in.-oz to several hundred in.-lb are possible. Jordan Co., Inc., 3235 W. Hampton Ave., Milwaukee 9, Wis.

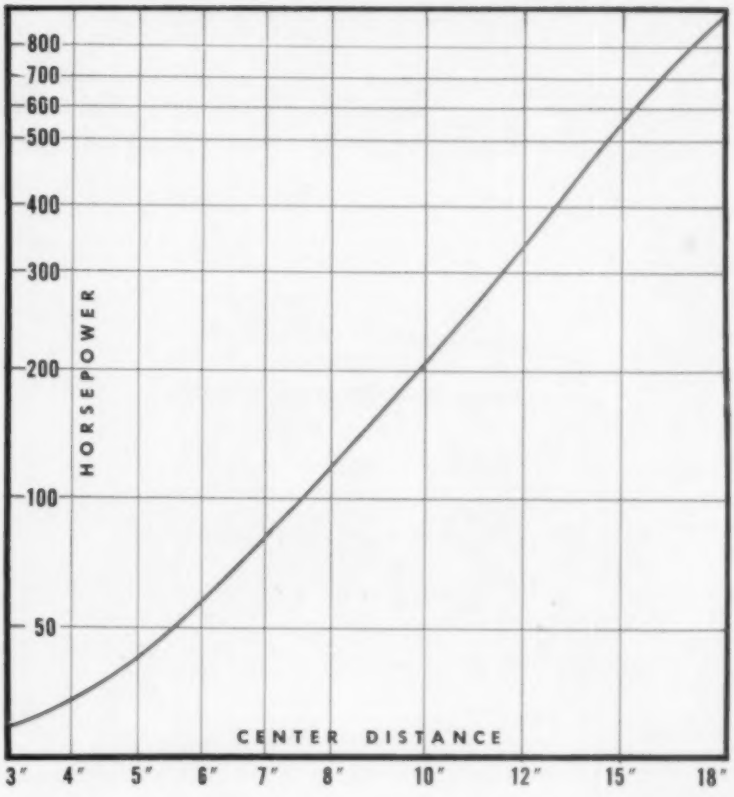
For more information—
Circle 60, inside back cover

Electro-Hydraulic Machine Control

A transistorized servo amplifier and an electro-hydraulic servo valve make possible electro-hydraulic control of industrial machinery, with electronic signal sensing and hydraulic control of variable delivery pumps, hydraulic motors, cylinders, and similar equipment. The amplifier is designed to receive signal inputs from any standard 60-cps, a-c signal source. Manually variable controls may be used. The control source can be a function of position, velocity or other command variable, or input signals from tracers

(Continued on page 254)

"DO-IT-YOURSELF"



Prove the difference in worm gear speed reducers yourself. Here's how . . .

. . . On this chart we've plotted the mechanical horsepower capacity of Cone-Drive worm gear speed reducers against their center distances. Ratings are for Class I Service with a 5:1 reduction and an input speed of 1750 rpm.

All you have to do is plot the corresponding ratings for the speed reducers you're now using or planning to use. We think you'll be surprised at the results.*

For details on Cone-Drive gearing's double-enveloping design and specifications, ask for Bulletin 600C. We'll send it to you immediately without obligation.

*If you're too busy to "Do-it-yourself", Cone-Drive representatives will be glad to show you filled-in charts.

CONE-DRIVE GEARS
DOUBLE ENVELOPING GEAR SETS & SPEED REDUCERS
Division Michigan Tool Company
7171 E. McNichols Road • Detroit 12, Michigan

for VOLVO

(a product of superb Swedish engineering)

...FOSBOND®

zinc phosphate rust-protection

Welcome to America, VOLVO! You're a sensation abroad . . . you're becoming the most popular family sports car here! And American buyers can buy the three great VOLVO models* with confidence that all painted metal is well protected against rusting and paint-peeling with Pennsalt's famous FOSBOND zinc phosphate coating.

VOLVO is another quality name in the automotive field being protected by Pennsalt FOSBOND. More and more metal-products manufacturers are turning to Pennsalt know-how to obtain a better start for *their* finish —from cleaning, through surface-activation, to the ultimate in phosphate protection.

WANT TO KNOW MORE about how FOSBOND and Pennsalt's long experience in metalworking chemistry can help you improve *your* finish and reduce your costs? Just call the Pennsalt man, or write directly to Metal Processing Dept. 374, Pennsylvania Salt Manufacturing Co. East: Three Penn Center Plaza, Philadelphia 2, Pa.; West: 2020 Milvia Street, Berkeley 4, Calif. In Canada: Pennsalt Chemicals of Canada, Hamilton, Ontario.

*VOLVO PV444 Sedan, VOLVO "Duett" Station Wagon, VOLVO Sports Car

Pennsalt Chemicals

Metal Cleaners • Phosphate Coatings • Cold-Working Lubricants

A BETTER START FOR YOUR FINISH

NOBLITT-SPARKS

Faultless CASTER MATERIALS HANDLING FACTS

CHANCE VOUGHT AIRCRAFT, DALLAS, PROTECTS EMPLOYEES ON MOBILE SCAFFOLDS WITH FAULTLESS DOUBLE LOCKING CASTERS

A completely safe, stable, and mobile work scaffold is being used by Chance Vought Aircraft, Dallas, in conjunction with precision assembly work on F7U-3 Cutlass frames and engines. Production of this important Navy fighter created many new manufacturing requirements. One was the complete redesigning of castered work scaffolds. Chance Vought's Plant Engineering, Safety and Maintenance Departments attacked this problem with the aid of Faultless engineers. After a careful review of scaffolding styles and available casters, they selected the Faultless F900 Series scaffold caster, which had been sampled, tested and approved. Combining a well designed scaffold with the Faultless double ball bearing casters has resulted in the development and use of equipment that easily meets all their requirements.

PROTECTS WORKERS ON RACKS, LADDERS, SCAFFOLDS, PLATFORMS

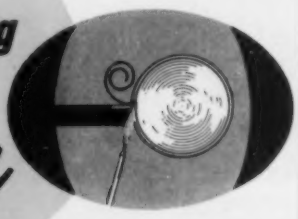
The Faultless F900 Series is designed with an easy-to-use foot-operated brake lever which simultaneously locks both swivel and wheel. It is thus possible to greatly simplify the design and increase the safety of the scaffolds. Brake shoe compensates for wheel wear to insure full braking action at all times.

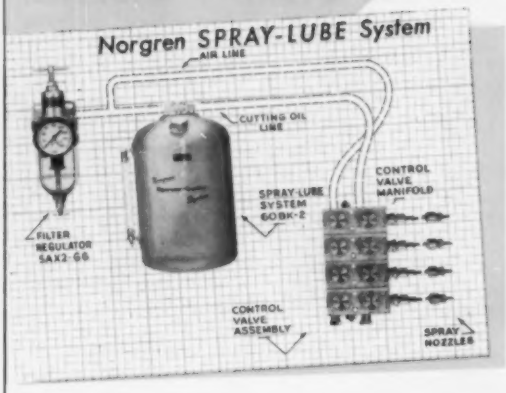
Faultless castered work stands are highly maneuverable and easily group-packed when not in use. Do YOU have a work platform problem? Our experienced engineers will gladly provide you with helpful caster data if you simply phone or write, no obligation.

SERIES F900 MEDIUM DUTY SWIVEL TRUCK CASTER
The F900 Series incorporates precision formed, and hardened double ball bearing swivel construction. The lower raceway is machined from steel bar stock for surplus strength and long life. Shown with Vulcanized Tired Wheel. Available with Semi-Steel, Renewable Tired, Ruberex and Plaskite Wheels.

FAULTLESS CASTER CORPORATION, EVANSVILLE 7, INDIANA
Offices in Atlanta, Baltimore, Boston, Buffalo, Chicago, Cleveland, Dallas, Detroit, Grand Rapids, High Point, Indianapolis, Los Angeles, New Orleans, New York, Philadelphia, Portland, Seattle, St. Louis, Canada: Stamford, Ontario

Faster Metal Cutting at LOWER COST with improved Norgren SPRAY-LUBE





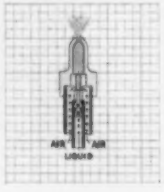
for
Tapping Machines
Drill Presses
Milling Machines
Grinders
Lathes
Boring Machines
High-Speed Saws
Stamping Presses
Die Lubrication
Other Metal Working Equipment

TOOL WEAR IS LESS—SAVES TOOL COSTS, CUTS DOWN-TIME—A better, more uniform spray of cutting oil is applied directly upon the close interface between the tool and work piece, providing better lubrication.

FASTER CUTTING, MORE OUTPUT—Because of the larger fluid surface area of the spray and the expansion of the compressed air, heat is dissipated quicker.

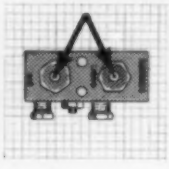
More Uniform Spray

Air and oil, conveyed separately to nozzle by a tube within a tube.



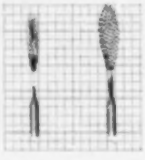
Tamper-Proof Controls

Allen-head screws are provided for air and liquid flow control.



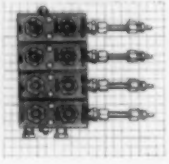
Accurate Control of Spray

Easily controlled to provide the right quality and quantity for any metal working job.



Valves Compactly Manifolded

Saves space on multiple lubrication job.



Compact, Convenient Size

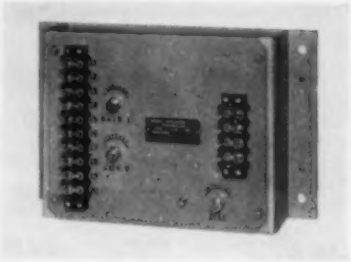
A space only 14"x20"x7" is required for a 2-gallon unit—4 to 12 fluid ounces of liquid an hour per nozzle are sufficient for most operations.

C. A. Norgren Co.

3428 So. Elati St., Englewood, Colo

Without obligation, learn how Improved Norgren SPRAY-LUBE can reduce costs in your plant. Call your nearby Norgren Representative listed in your telephone directory—or **WRITE THE FACTORY FOR BULLETIN 537.**

Pioneer and Leader in Oil-Fog Lubrication Since 1930



or computers can be employed. The amplifier is designed for parallel summation, ratio comparison, or series summation of input signals. Output is designed to power a balanced single load, or split loads, of as high as 5 w. Minneapolis-Honeywell Regulator Co., 2753 Fourth Ave., S. Minneapolis, Minn.

For more information—
Circle 61, inside back cover

Timing Motor

Said to provide dependable power between 1 rpm and 1 rph without extra gears, torque rating is 20 in.-oz at 1 rph. Motor is for use switches, timers and other control applications.

Speeds of the new motor are: 0.8 to 120 rph at 60 cps; 0.8 to 100.0 rph at 50 cps, and 1.0 and 2.0 rph at 25 cps. It is available with one-way or two-way clutch. Hansen Mfg. Co., Princeton, Ind.

For more information—
Circle 62, inside back cover

Transducer-Amplifier

This unit is of plug-in construction intended for pre-amplifier service. The amplifier output embraces a ground and maintains a zero output voltage for a zero input voltage. Variations in

(Continued on page 255)

plate supply voltages, filament voltages, and tube characteristics are said to be automatically compensated for. Avionic Products Engineering Co., Dover, N. J.

For more information—
Circle 63, inside back cover

A-c Power Supply

Nominal input is 115 v, 60 cps, and output rating is 3 amp, with voltage infinitely variable from 0 to 135 v. Slaughter Co., Piqua, Ohio.

For more information—
Circle 64, inside back cover

Servoamplifier for Control Systems

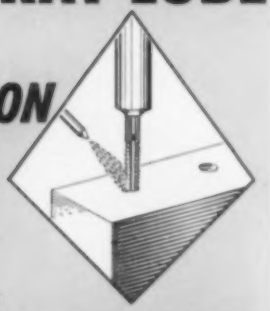
The servoamplifier is used for applications in which the amplification of minute 60 or 400 cps signals is required to produce up to 4 w of controllable power, to actuate relays, power small motor windings or for

(Continued on page 258)

Norgren SPRAY-LUBE

INCREASES PRODUCTION from MACHINE TOOLS

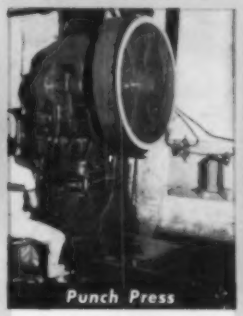
- Increases Tool Life
- Improves Quality of Work
- Reduces Maintenance Costs



Metal Cutting Saw

CUTS FASTER . . . DOESN'T OVERHEAT

Oliver Sawing Machine cuts 4" to 6" slabs of non-ferrous metals. By changing to SPRAY-LUBE: (1) Fusion of chips to saw teeth ended. (2) No galling—surfaces now resemble machined finish. (3) Saw feed faster—cuts 6" aluminum slabs at 5 fpm.



Punch Press

OUTPUT INCREASED 15% DIE LIFE INCREASED 100%

Formerly lubricated by hand swabbing every 6 cycles of press, splashing on machine, floor and operator. Now, SPRAY-LUBE automatically lubricates die and blank every cycle, increasing die life 100% and output 15%. Lubricant cost cut in half.

Tapping Machine

30% MORE OUTPUT

SPRAY-LUBE replaced flood system on tapping machine at the Square D Company, eliminating excess of lubricant and ending time lost for cleaning parts. Splashing lubricant on operator and floor also ended. Production increased 30%.

Gear Hobbers

$250 A YEAR LUBRICANT SAVING PER MACHINE

Cullman Wheel Co. replaced splash coolant systems on gear hobbers with SPRAY-LUBE. Results: (1) Tool life increased. (2) Tool grinding time reduced. (3) Working conditions cleaner, safer. (4) $250 a year per machine saved in lubricant costs.

Turret Lathe

OUTPUT DOUBLED

SPRAY-LUBE on lathe at O.K. Rubber, Inc. has: (1) Increased surface cutting speed from 45 to 75 rpm, nearly doubling output of machine. (2) Ended welding of chips to tool. (3) Increased depth of cut. (4) Improved quality of work.

Chain Drive

OVER TWO TIMES LONGER CHAIN LIFE

At Wagner Electric in St. Louis, SPRAY-LUBE automatically lubricates chain drive on degreasing machine. Chain now runs smoothly and quietly. Lubricant, removed by the hot cleaning solution, is now constantly replaced, doubling chain life.

For complete information about Norgren SPRAY-LUBE, call your nearby Norgren Representative listed in your telephone directory—or WRITE THE FACTORY for Bulletin 537.

C.A. Norgren CO.

C. A. NORGREN CO. 3428 So. Elati St., Englewood, Colorado

3N

Your source for BIG Cap Screws for big jobs

...Cleveland's *Top Quality*

EXTRA LARGE SIZES

Modern developments in things of massive size—earth moving and road building machinery, hydraulic equipment and other unusually large assemblies—have increased the need for extra large Cap Screws.

Anticipating this demand, Cleveland will install the world's largest Boltmaker which will produce *in volume,* cap screws up to 1¼" x 10".

Every day we're shipping diameters up to 2½", in lengths as required. Occasional special orders call for greater diameters, even up to 4 inches. Of course, size alone doesn't always provide required physical properties. Close attention to steel selection, testing and preparation, strict control throughout manufacturing processes, and final critical inspection assure you cap screws of *known strength* as well as brute size.

Physical properties of Cleveland Cap Screws in various styles up to 2½" diameter are shown on our handy chart. Write or wire for delivery and price information on extra large Cap Screws.

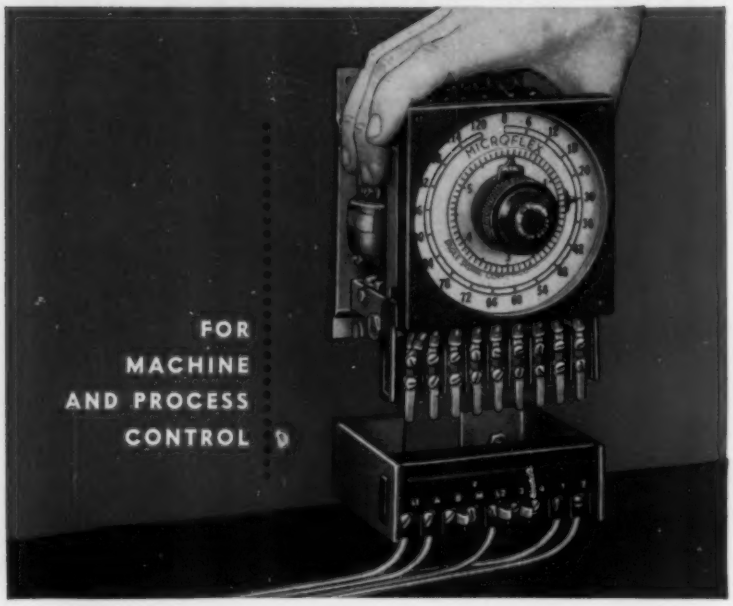
The Cleveland Cap Screw Company

2936 East 79th Street • Cleveland 4, Ohio • VUlcan 3-3700 TWX CV-42

Warehouses: Chicago • Philadelphia • New York • Providence • Los Angeles

...22,461 SALESMEN
on the job every day for
ILLINOIS
GEAR
The more than 22,461 customers of ILLINOIS GEAR . . . and every one a satisfied customer . . . are the hardest working salesmen ever.
Gears they use are on the job every day . . . telling the story of outstanding quality and performance that characterizes Illinois Gears.
The great array of fine equipment and machinery of which they are a part is indicative of the wide range of types and sizes of Illinois Gears . . . America's most complete line of gears.
Regardless of the service, whether it's gears for rotating massive shovels, or gears that control delicate precision equipment — depend on ILLINOIS GEARS.
Look for this mark ILG the symbol on finer gears
ILLINOIS GEARS
Gears for Every Purpose ... one gear or 10,000 or more
ILLINOIS GEAR & MACHINE COMPANY
2108 NORTH NATCHEZ AVENUE • CHICAGO 35, ILLINOIS

EAGLE
Microflex Reset Timer



NOW . . . quick plug-in connection!

See that new-design terminal panel? Terminals are all in a row. So you can quickly and easily adapt the Microflex Reset Timer to plug-in connection. Simply use a Microflex Plug-In Kit, available in all accepted variations. You can even rotate the terminal panel for rear connection — (just loosen two screws) — without any rewiring.

Time settings of pinpoint accuracy are possible with the Microflex double dial. Through precision vernier action, one complete turn of the *inner* dial advances the *outer* dial just one division. That's a 20-to-1 ratio, made possible by a patented Microflex threaded axle and pinion. Accuracies are obtainable to 1/60 second. Over 150 timer operating combinations, plus a wide range of long or short time periods. The ideal timer for molding presses, dielectric heating, automatic mixing, die casting machines, machine tools and rubber curing.

Write for FREE AUTOMATION BOOKLET and Bulletin 110.

MAIL COUPON TODAY

EAGLE SIGNAL CORPORATION
Industrial Timers Division, Dept. PE-1256
MOLINE, ILLINOIS

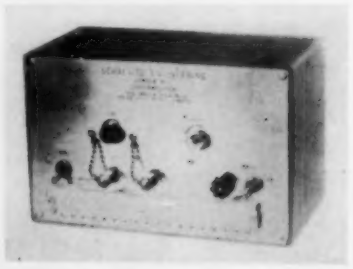
Please send FREE AUTOMATION BOOKLET and Bulletin 110 containing complete data on Microflex Reset Timers.

NAME AND TITLE

COMPANY

ADDRESS

CITY ZONE STATE



any suitable load sensitive to phase inversion. When operated in response to the displacement of the core of a linear variable differential transformer, measurements may include force, weight and stress, linear displacement, pressure, liquid flow, level, torque and surface contour. The primary actuating signal is a variable carrier voltage.

Power requirement is 105 to 130 v, 60 or 400 cps. Power consumption is 30 w nominal; maximum carrier output: 4 w. Dimensions are 9¼ x 4¾ x 5¾ in. high. Schaevitz Engineering, P.O. Box 505, Camden 1, N. J.

For more information—
Circle 65, inside back cover

Permanent Adhesive Label

This contact label is for use where an easily affixed but practically impossible to remove label is required. They are used to carry brand information, instructions, wiring or installation diagrams or other information of a permanent nature. Archer Label Co., 783 Kohler St., Los Angeles 21, Calif.

For more information—
Circle 66, inside back cover

Noise Suppression Filter

A miniature shock-resistant rf noise suppression filter contains eleven capacitor sections, eleven toroids, and two resistors. Astron Corp., 255 Grant Ave., E. Newark, N. J.

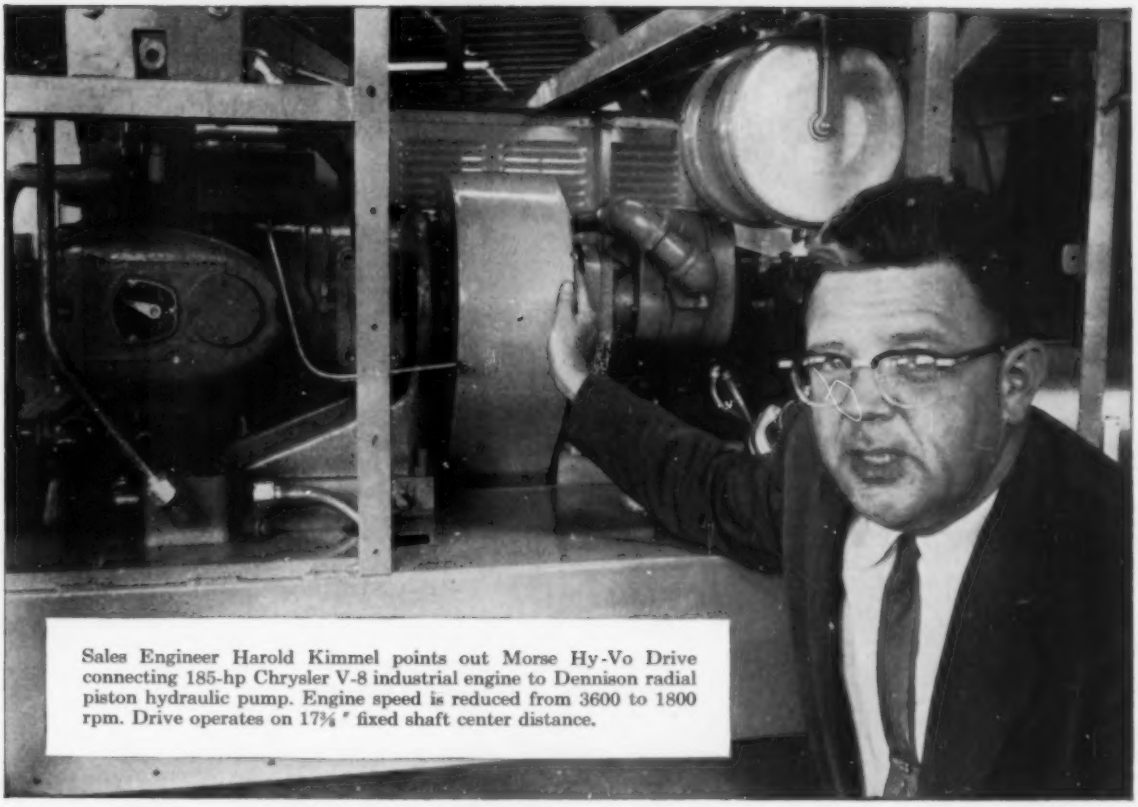
For more information—
Circle 67, inside back cover

Single Point Thermometer

This thermometer can be calibrated for any single desired point between −40 F and 1000 F or between −10 C and 300 C. Dial housing measures 1⅛ in. Model illustrated is equipped

(Continued on page 263)

Morse HY-VO Chain offers designers high-hp capacity; space and cost savings



Sales Engineer Harold Kimmel points out Morse Hy-Vo Drive connecting 185-hp Chrysler V-8 industrial engine to Dennison radial piston hydraulic pump. Engine speed is reduced from 3600 to 1800 rpm. Drive operates on 17¾" fixed shaft center distance.

Morse Hy-Vo's exclusive rocker-joint design and freedom from chordal action reduce wear and friction, eliminate stretch, and permit fixed shaft centers.

Narrow Hy-Vo Drive transmits power smoothly, efficiently at 6,250 fpm in new jet-engine starter.

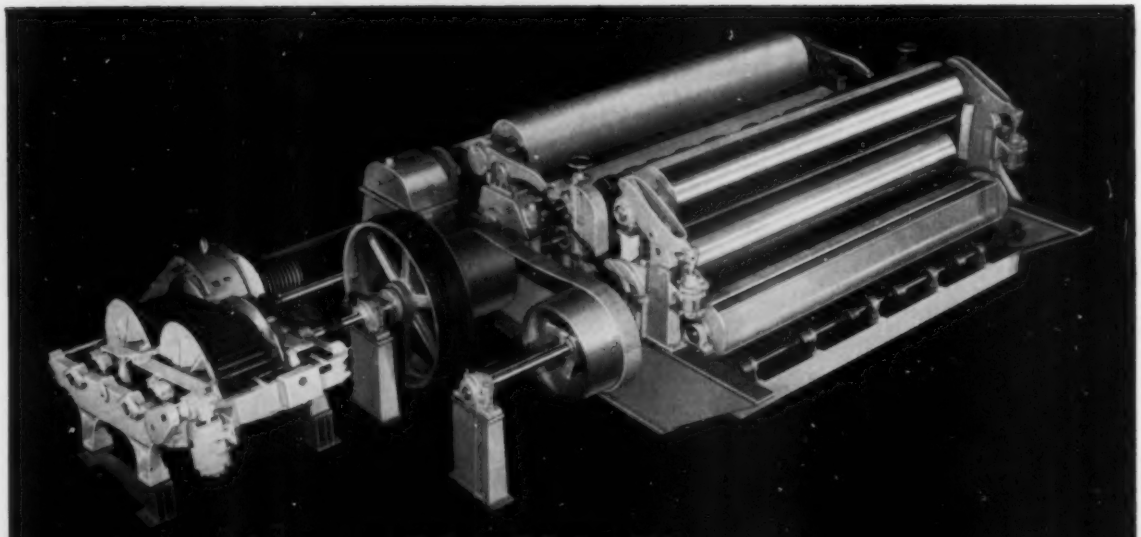
In building the Pre-Flight Equipment Jet Hydrostarter, the basic design problem was to find a compact, efficient method of transmitting power from the primary motor to the pumps which actuate the hydraulic starting motor. In addition to providing a 50% speed reduction, the power transmission unit had to withstand reactive shock loads up to 100 hp, occurring each time the jet fuel is ignited.

The solution was a stock Morse Hy-Vo Drive only 3" wide. This compact unit proved to be the most economical method of transmitting the required HP at high speed in the limited space.

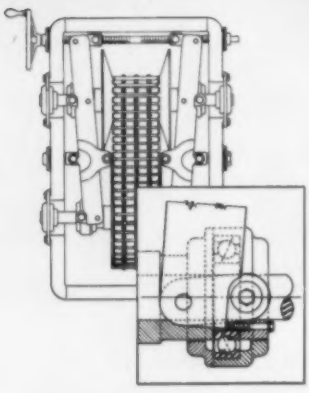
Hy-Vo Drives are built for maximum-load-carrying capacity per inch of width at both high and low speeds. They provide smooth, efficient power transmission at speeds up to 8500 fpm.

Call or write for complete information and engineering assistance on Morse Hy-Vo Drives. MORSE CHAIN CO., A BORG-WARNER INDUSTRY, ITHACA, N. Y.

MORSE MORSE BW •Trademark **POWER TRANSMISSION PRODUCTS**



"Only LEWELLEN V/S TRANSMISSIONS give precision ratios"



Internals of Lewellen V/S Transmissions are mechanically connected and symmetrically positioned. All motions are exactly proportioned and accurately adjustable. V/S Belt tracks in true alignment at precise pitch ratios, with controlled tension for full traction throughout the speed range. Infinitely, accurately variable speeds are designed and built into Lewellen V/S Transmissions.

The builder of Lamb-Grays High-Speed Precision Cutter says, "Only Lewellen V/S Transmission gives the precision ratios we require, at the extreme variations in torque resulting from rapid accelerations of the cutter."

The Lewellen variably drives the rotary shear. Speeds are remotely controlled for a wide range of selected sheet lengths.

Recurring peak loading at the cut, rapid accelerating loads at frequent starts, and 24 hour service are exacting requirements.

The uniform lengths of the stacked sheets is indisputable evidence of Lewellen accuracy.

Lewellen V/S Transmissions offer convenience as well as utility. Lewellens operate at the speeds that machines run. Directly connect machine sections—or, motorized, variably power the machine.

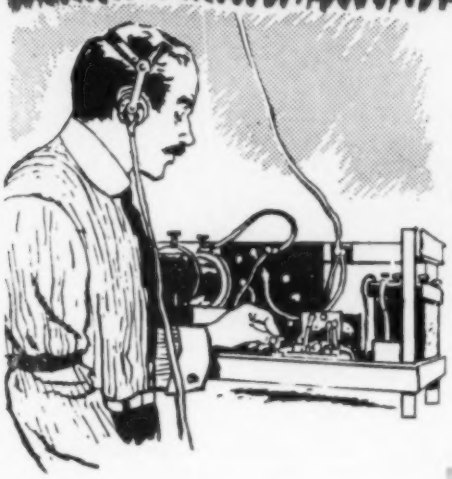
Four standard models—selective controls—many accessories—any driving arrangement . . . Lewellen V/S Transmissions adapt readily to any equipment.

WRITE FOR CATALOG NO. 65

LEWELLEN MANUFACTURING CO. COLUMBUS, INDIANA

Distributors In All Industrial Areas • In Canada—Peerless Engineering Sales Ltd., Toronto-Montreal

75 years ago and 14 years before the first Practical Wireless was invented



Koven was making individualized equipment parts

Older even than the radio, KOVEN has devoted 75 years of application and research to the task of creating individualized equipment parts which fulfill the exact needs of equipment manufacturers. With its particular skills and concentrated experience, KOVEN produces these parts often faster and more economically than equipment manufacturers themselves—facilitating within the industry faster, more efficient production at lower costs.

If you haven't already inquired about KOVEN individualized equipment parts, do so now. Call or write for a consultation with a trained KOVEN representative, and send for Bulletin #550 There's no obligation.

X-RAY INSPECTION FOR QUALITY CONTROL

KOVEN equipment in all metals and alloys includes: High pressure vessels built to A.S.M.E., A.P.I. Codes; extractors; mixers; stills; kettles; tanks; stacks; breechings; hot transfer lines; light and heavy fabricated piping and plate exhaust ducts. Shop and field erected storage tanks to 2 million gallons. High vacuum testing on liquid oxygen storage tanks.

Jacketed Stainless Steel Fermenters.

Stainless Steel Tower.

SPECIALISTS IN INTRICATE FABRICATION USING:

- **STAINLESS STEEL**
- **ALUMINUM**
- **MONEL**
- **NICKEL**
- **INCONEL**
- **ALL CLAD MATERIALS**

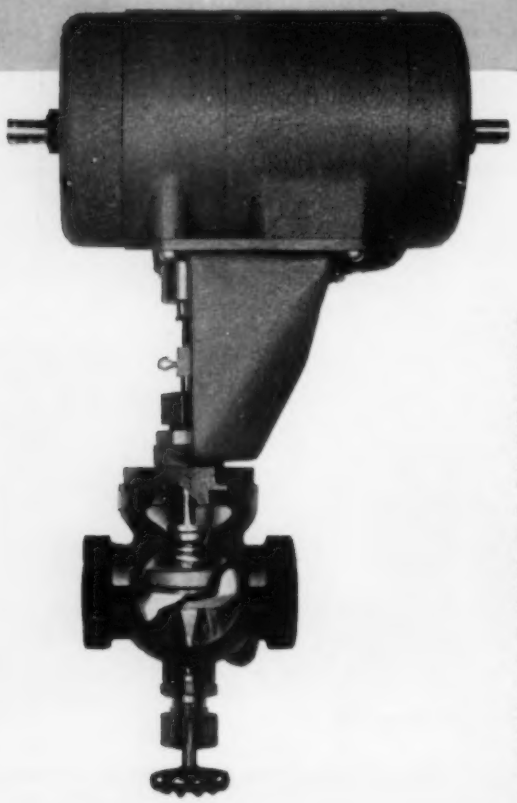
Fabrication to all A.S.M.E. Codes

Koven *FOR INDIVIDUALIZED EQUIPMENT SINCE 1881*

L. O. KOVEN & BRO., INC. • 154-C OGDEN AVE. • JERSEY CITY 7, N. J.
PLANTS: JERSEY CITY, N. J. • DOVER, N. J. • TRENTON, N. J.

NEW ACTIONATOR*

heavy duty electric motor for operating valves, dampers, louvers



The new Honeywell ACTIONATOR is a compact, lightweight, rugged and flexible industrial motor for operating valves, dampers, louvers, and other final control elements. Models are available for mounting on, and operating rotary valves or dampers. The ACTIONATOR is also available with cam operator and yoke. Internal strain release protects valve seats and gear train so that it can be used on practically any slip stem valve.

The ACTIONATOR is a reversing capacitor type motor and provides on-off, two-position, floating or proportional control. Shaft rotation can cover up to 180 degrees in 7½, 30, 60, or 120 second timings; torque ratings from 50 to 200 inch-pounds depending on motor speed.

The proportional control model provides slidewire resistances of 100, 135 or 1000 ohms, and can be used with any type of electric proportional controller. A second slidewire can be used for retransmission . . . to operate another motor, or for remote indication. Spst and spdt auxiliary switches can also be installed within the end bells. The enclosed terminal compartment is designed to meet J.I.C. standards.

Limit and auxiliary switches, specially designed by MICRO SWITCH, allow the ACTIONATOR to be used where ambient temperatures range from −20 to +150 F.

For complete information and specifications on the new ACTIONATOR, call the nearest Honeywell office, or write (send coupon) to:

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Phila. 44, Pa.

Industrial Division
MINNEAPOLIS-HONEYWELL REGULATOR CO.
Wayne and Windrim Avenues, Philadelphia 44, Pa.

☐ Please send me additional information on the ACTIONATOR.

☐ I'd like a Honeywell sales engineer to discuss applications of the ACTIONATOR in my plant.

Name_____

Title_____

Company_____

Address_____

MINNEAPOLIS **Honeywell**

First in Controls

*Tradename Minneapolis-Honeywell Regulator Co.

with a plain bushing; however, ¼, ¼, ⅜ in. or ⅜-24 x ½ in. thread mounting nuts are all available. Stem lengths from as short as 2½ in. up to 70 in. long can be furnished. W. C. Dillon & Co., Inc., P. O. Box 3008, Van Nuys, Calif.

For more information—
Circle 68, inside back cover

Surface Temperature Thermometer

A maximum-minimum surface temperature thermometer, of stainless steel, has a range of 50 to 1000 F. Two ancillary pointers show the maximum and minimum excursions of the thermometer over any desired period of time.

The maximum and minimum pointers can be re-set whenever a reading is taken. The diameter is 1¾ in. overall, and the weight ½ oz.

This thermometer reads accurately the temperature of all surfaces, such as dies, hot plates, heavy sheet metal, furnace skins, large super-heated pipes, cooling billets. Besides surface temperatures, it also provides a maximum and minimum record of temperatures in furnaces, ovens and other enclosed spaces, as well as non-corrosive liquids and gases, up to 1000 F. An Alnico magnet is provided for attachment to ferrous surfaces. Pacific Transducer Corp., 11836 W. Pico Blvd., Los Angeles 64, Calif.

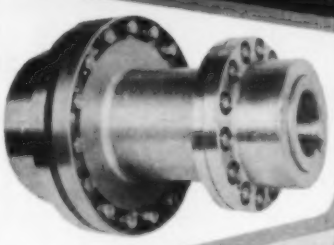
For more information—
Circle 69, inside back cover

Miniature Two-Way Clutch

The function of the shafts in a line of electro-magnetic clutches may be reversed, so that a single input can

(Continued on page 266)

Does your problem call for a Specially Built Coupling?



Specially designed Coupling for use in a wind tunnel

WALDRON Coupling hub with special plate provides required sliding motion

then put your problem up to

Waldron

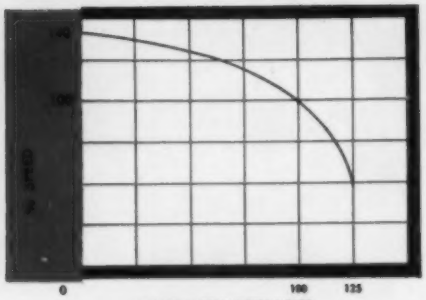
The extensive engineering and manufacturing facilities maintained for the production of our popular standard type couplings put WALDRON in the most favorable position for handling special orders. WALDRON is the recognized source for prompt service on unusual coupling applications.

JOHN WALDRON CORP. • NEW BRUNSWICK, N. J.

Sales representative in Principal Cities

STANDARD TYPES — Waldron COUPLINGS — SPECIAL TYPES

Factors Determining the Choice of HOWARD FRACTIONAL H.P. *INDUCTION MOTORS*

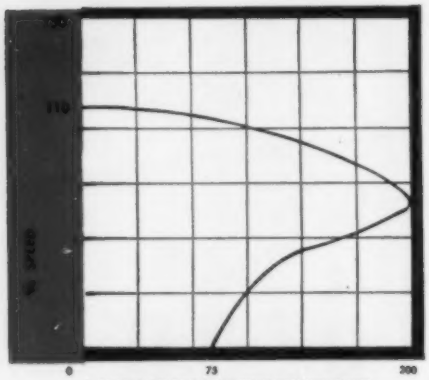


TORQUE TYPE MOTOR

POWER: AC 50 to 60 cycles.

CHARACTERISTICS:

1. No Load speed is determined by number of poles, with a No Load slip of approximately 5%.
2. Full Load speed decreases with an increasing load. Designed to operate at approximately 30% full load slip.
3. No breakdown torque.
4. Starting torque high approximately 125% full load.



INDUCTION CAPACITOR RUN TYPE MOTOR

POWER: AC 50 to 60 cycles.

CHARACTERISTICS:

1. No Load speed is determined by the number of poles, with a no load slip of 2 to 4%.
2. Constant Full Load speed, with a full load slip of approximately 10%.
3. Breakdown torque—approximately 200% full load.
4. Starting torque—approximately 75% full load.

HYSTERESIS SYNCHRONOUS TYPE MOTOR

POWER: AC 50 to 60 cycles.

CHARACTERISTICS:

1. Synchronized speed, determined by number of poles.
2. Starting torque equal to Full Load Torque.
3. Quiet operation.

RELUCTANCE SYNCHRONOUS TYPE MOTOR

POWER: AC 50 to 60 cycles.

CHARACTERISTICS:

1. Synchronized speed, determined by the number of poles.
2. Starting Torque Low, 50 to 75% of Full Load.

HOWARD

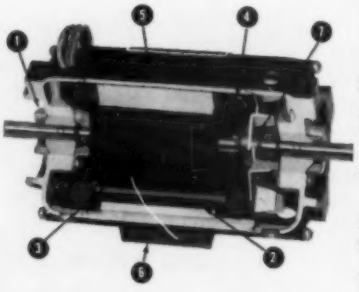
The increase in the use of Howard Induction Motors results from the overall superior performance characteristics of Induction motors over Series and Shaded Pole types.

basically Howard Induction motors have the following advantages:

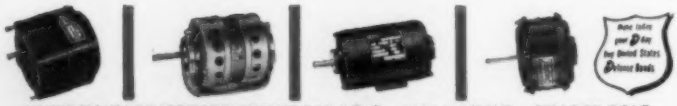
- Less maintenance—no brushes to wear, parts subjected to less wear. For applications where maintenance is difficult to handle.
- Constant speed under increasing load or varying power supply—for applications with exacting timing requirements where load or power supply are not constant.
- Extremely quiet operation both mechanically and electrically—for applications where noise level must be exceptionally low, professional tape recorders, etc.
- Low external field, in many cases requiring no magnetic shielding.
- Good efficiency up to 50% as against 40% maximum in Shaded Pole motors and 65% in Series motors.
- High power factor up to 85%.
- No radio or TV interference—for appliances and other home use applications.
- Good starting torque.
- Reversible in motion and reversible from rest.
- Wide range of H.P. ratings (1/8 to 1/1400) and gear ratios (2:1 to 3600:1).

Howard Induction Motors are currently used in a wide range of applications—business calculators, tape recorders, facsimile equipment, blowers for microwave relay stations, radar, projectors, teleprinters, gyro drives, automation instruments, etc.

Howard Induction Motors are available in Torque, Induction Capacitor Run, Hysteresis Synchronous and Reluctance Synchronous types. Costs are moderate but depend upon quantity. For full information on Howard Induction Motors, write for bulletin 56A.



1. "Selected" ball bearings permanently lubricated, sealed and shielded or sleeve bearings with large felt oil reservoirs with oil return system (shown). Sleeve bearing motors can be provided with ball thrust bearing for vertical operation or thrust loading.
2. 24 slot lamination design for quiet, cool operation. Stamped from high grade electrical steel.
3. Rotors dynamically balanced, skewed to give uniform torque characteristics with change of rotor angle.
4. Windings of heavy Formex insulated wire, impregnated and baked with top grade electrical varnish.
5. Case of sturdy, rigid casting always.
6. Mounting pads with holes drilled and tapped cast on frame. Special face mounting end bell available.
7. Internal fan for cooling.



OTHER HOWARD MOTORS: UNIVERSAL & D.C.—1/200 to 1/2 H.P. • SHADED POLE—1/2000 to 1/10 H.P. • SERVO MOTORS • GEAR MOTORS • BLOWERS

DEPT. PE-12 • HOWARD INDUSTRIES, INC. • RACINE, WIS.

SALES OFFICES: 208 S. La Salle St., Chicago 4
942 S. La Brea Ave., Los Angeles 36 • Room 4822, Empire State Bldg., New York 1

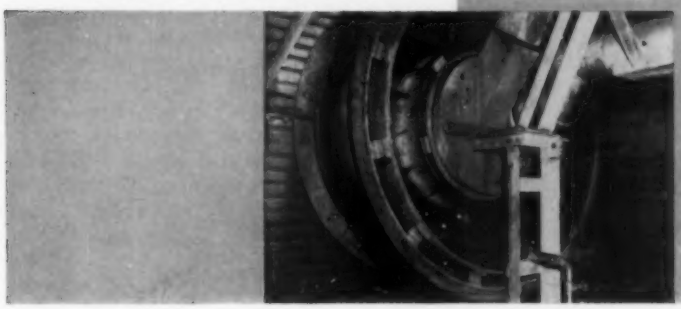
DIVISIONS: EMC ELECTRIC MOTOR CORPORATION · CYCLOHM MOTOR CORPORATION · RACINE ELECTRIC PRODUCTS

How designers use **Porcelain Enamel**

to reduce costs

Porcelain Enameled pump cylinder wears longer and costs less than special alloys.

Pump plunger employed in oil field operations. Porcelain Enamel is more durable, reduces field service.



Spout for rotating dryer resists corrosion, abrasion and thermal shock because it is Porcelain Enamel.

Porcelain Enamel has proved to be an effective aid to designers in reducing costs. In a variety of ways, its unique properties are employed to effect savings in manufacturing and materials expense.

REPLACES COSTLY MATERIALS. Porcelain Enamel provides a non-porous, inorganic, glass-hard surface that makes it ideal for service where corrosion, abrasion and/or high temperatures prevail. Consequently, Porcelain Enamel can frequently replace costly high alloy or other metals.

REDUCES WEIGHT. The intimate fusing of the inorganic coating to the base metal materially increases the strength and rigidity of the product, thereby permitting weight-reduction in many of its applications. Its thermal-shock resistance makes thinner sections possible.

REDUCES FIELD SERVICE. A very practical advantage provided by Porcelain Enamel is reduction in field service. Where conditions of rust, corrosion, abrasion, high temperatures or thermal shock prevail, Porcelain Enamel resists attacks that would otherwise call for repairs and field service to the equipment. This not only saves money for the manufacturer, but also can be used as a powerful sales advantage.

Are you interested in knowing more about these benefits provided by Porcelain Enamel? We'll be glad to help you get the specific information you want. Let us know your problem, and we'll put you in touch with Porcelain Enamel Manufacturers, qualified to advise you.

PORCELAIN ENAMEL
PORCELAIN ENAMEL INSTITUTE, INC.

This message sponsored by the Frit Division of the

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Please send me design information about PORCELAIN ENAMEL for possible application to_____
(type of product)

Name_____

Company_____

Address_____

In the
old tradition of
Craftsmanship...

with modern design
and engineering...

Accurate CREATES a Spring

Accurate *CREATES* a Spring
—because Accurate approaches spring problems
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Accurate Spring combines old fashioned
craftsmanship, modern design and engineering,
and the most efficient production methods
to produce the finest of springs
at the lowest possible cost.

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Accurate Springs

SPRINGS
WIRE FORMS
STAMPINGS

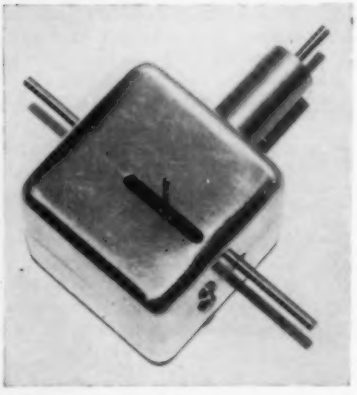
ACCURATE SPRING MANUFACTURING COMPANY

3815 W. Lake Street • Chicago 24, Illinois

be connected to either of two output shafts. These units are said to be suitable for use as a speed or direction changer in servo-type applications. The clutches operate on d-c voltage.

Typical of the performance of the three sizes available are torque ratings of 3.5 to 52 in.-oz. Weight ranges from 1 to 8.8 oz. A. J. Thompson, Inc., Route 1, Box 812, Florissant, Mo.

For more information—
Circle 70, inside back cover



Mechanical Integrator

A floating ring integrator, consisting basically of a disc, drum and ring, requires less than 0.5 g to position the ring. The ring controls the output drum shaft speed relative to the input disc shaft speed. Negligible force is required to maintain the ring's posi-

(Continued on page 268)

TOTALLY ENCLOSED, NON-VENTILATED

TOTALLY ENCLOSED FAN COOLED

MOST BEAUTIFUL MOTORS IN ALL THE WORLD...

NEW REULAND PRECISION MOTORS FOR MACHINE TOOLS

Designed especially for machine tool manufacturers

Reuland precision motors were developed only after giving a lot of careful thought to the problems of the machine tool industry. They are not just another line of motors that can be "made to fit," but rather, a complete new type especially made for machine tool manufacturers.

They are available in T.E.N.V. and T.E.F.C. types. Small, compact and featuring the very latest in lightweight materials.

For good looks and precision operating characteristics, there is nothing on the market to equal these jewel-like units.

Precision balance

Reuland motors are built to precise specifications like a fine tool. Each unit is dynamically balanced at the factory to assure vibrationless operation.

Heavy-duty ball bearings, located at each side of the rotor, assist in maintaining this characteristic which is so vital to precise work. Exact tolerances are likewise maintained throughout final assembly.

Low inertia rotor

The radial air gap design of these motors permits the use of a lighter weight, low inertia rotor. This light weight, low inertia feature assures smooth starts and quick stops.

This rotor is also of a special narrow design which has shortened up the overall length of the motor to give a thinner, "wafer" effect.

Smooth-finished castings —pleasing lines

The smoothly finished surfaces of Reuland machine tool motors are a match for the most expensive tool. All castings are specially processed for smoothness and are given a baked enamel finish.

This fine-quality finish, together with the motors' naturally pleasing lines, assure a harmonious blend with the lines of every machine tool on which they are mounted. (When desired, the motor's frame size can even be varied to fit an *exact* contour of the machine.)

Other Reuland firsts!

1. Motor with internal fluid coupling
2. Spline-coupled hydraulic pump motor
3. Foot-mounted disc type magnetic brake with self-contained bearings and shaft
4. "Through-Shaft" magnetic disc brakes
5. Slip Ring motors in small #66 frames
6. All-aluminum motor frames
7. "Xpandable" motor design

Use these other free Reuland Services

Special-Motor Library

Don't ever pay for special-motor development costs before you check this free library. Contains valuable data on hundreds of unique, specially designed motors. Send for free "how to use" booklet.

Standard Motor Catalog

Contains engineering information on Reuland's complete line of standard motors and motoreducers. Sent free on request.

REULAND MOTORS

REULAND ELECTRIC COMPANY

Western Division: Alhambra **63**, California
Eastern Division: Howell **63**, Michigan

Distributors in all principal cities

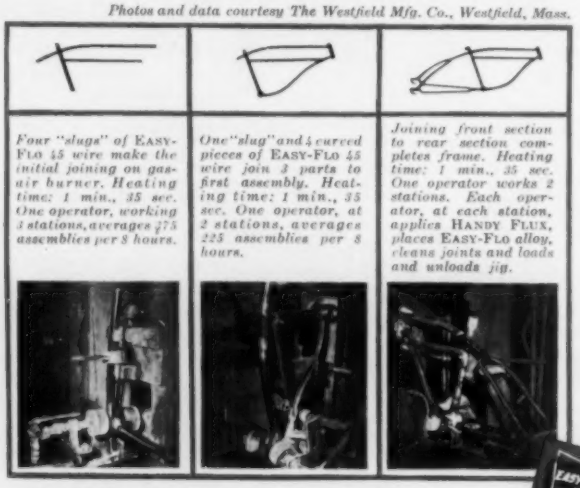
Here's Why Columbia Bicycle Frames Are

EASY-FLO BRAZED

The *speed* and *economy of labor* enjoyed with EASY-FLO silver brazing of tubular assemblies of all kinds are outstanding. The old method used by Columbia required 42 men to grind fillets and clean the brazed joints on 1000 frames a day. Now, with EASY-FLO and HANDY FLUX, 3 men do the finishing on the same number of frames. Five pieces of curved wire and five small slugs of EASY-FLO 45 are used to produce a frame that is as strong and indestructible as though it were one piece.

Here is the "joining sequence" of one of the many models of Columbia frames.

Photos and data courtesy The Westfield Mfg. Co., Westfield, Mass.


Four "slugs" of EASY-FLO 45 wire make the initial joining on gas-air burner. Heating time: 1 min., 35 sec. One operator, working 3 stations, averages 275 assemblies per 8 hours.
One "slug" and 4 curved pieces of EASY-FLO 45 wire join 3 parts to first assembly. Heating time: 1 min., 35 sec. One operator, at 2 stations, averages 225 assemblies per 8 hours.
Joining front section to rear section completes frame. Heating time: 1 min., 35 sec. One operator works 2 stations. Each operator, at each station, applies HANDY FLUX, places EASY-FLO alloy, cleans joints and loads and unloads jig.

GET COMPLETE EASY-FLO FACTS AND DISTRIBUTOR LIST.

BULLETIN 20 explains why high strength, speed and economy are inherent in EASY-FLO brazing. Also gives Handy information about joint design and fast brazing methods. Get your copy, with distributor list, by writing today.

Your NO. 1 Source of Supply and Authority on Silver Brazing Alloys

HANDY & HARMAN — FOUNDED 1867 — QUALITY & SERVICE

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General Offices: 82 Fulton St., New York 38, N. Y.

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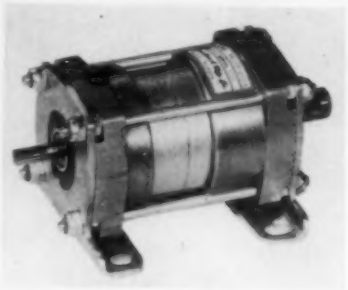
LOS ANGELES, CALIF.
TORONTO, CANADA
MONTREAL, CAN

tion under varying speed and load conditions.

The integrator is suitable for chart integrators, servo mechanisms, variable speed drives, linear-to-rotary motion converters. Optimum Engineering Co., 2017 Willow St., Grand Prairie, Texas.

For more information—
Circle 71, inside back cover



Planetary Gear Box

A planetary gear box is available with output torque ranging from 100 in.-lb to 250 in.-lb depending on gear ratio. Ball bearings are used on input shaft and oil-impregnated bearings on output and planets, together with hardened gear. The reducer can be furnished with leg or flange mounting. Arizona Gear & Mfg. Co., 3544 E. Fort Lowell Road, Tucson, Ariz.

For more information—
Circle 72, inside back cover

Silicone Rubber Conducts Current

A silicone rubber that will conduct electricity can be molded, calendered or extruded without appreciably changing its electrical properties. Silicones Div., Union Carbide and Carbon Corp., 30 E. 42 St., New York 17, N. Y.

For more information—
Circle 73, inside back cover

Self-Priming Pumps

This volute design is said to permit the pump to clear the suction line of air with only an initial priming charge of the liquid in the casing. The casing is so designed that when the pump is stopped, an adequate supply of the

(Continued on page 272)

For faster flow and freedom from plugging filter fluids with American Felt!

The very construction and character of wool felt make it a natural for filtering liquids. The unique, fibrous structure of wool felt has these outstanding advantages: 1—Efficient particle retention. 2—Minimum pressure drop with corresponding high permeability. 3—Maximum solids capacity resulting in greater liquid throughput. 4—High porosity value responsible for low plugging rate and ease in cleaning. 5—Chemical and thermal stability. 6—Felt's thickness permits free use of third dimension in design and in true edgewise flow.

American's Wool Felts for liquid filtration provide efficient and economical filter media for cellulose nitrate, solvents, hot lubricating oil, paint, lacquer, latex, water, food syrups, and oils. Their outstanding characteristics give them great versatility in method of use because of the high degree of porosity and the many types of felt constructions available.

For complete details write, on your company letterhead, for FREE, 10-Page Data Sheet No. 17 on "Wool Felt-Liquid Filtration". And remember: American Felt Company also produces engineered Synthetic Fiber Filter Felts.

Directly above is a microscopic (175x) view of wool felt demonstrating the filtration mechanism attributed to the Van der Waal Forces. Note how solids smaller than pore size (in red) are held on the fiber by molecular attraction; with minimum flow resistance and freedom from plugging. **SEND TODAY for this FREE, 10-Page Data Sheet No. 17. Please make request on company letterhead.**

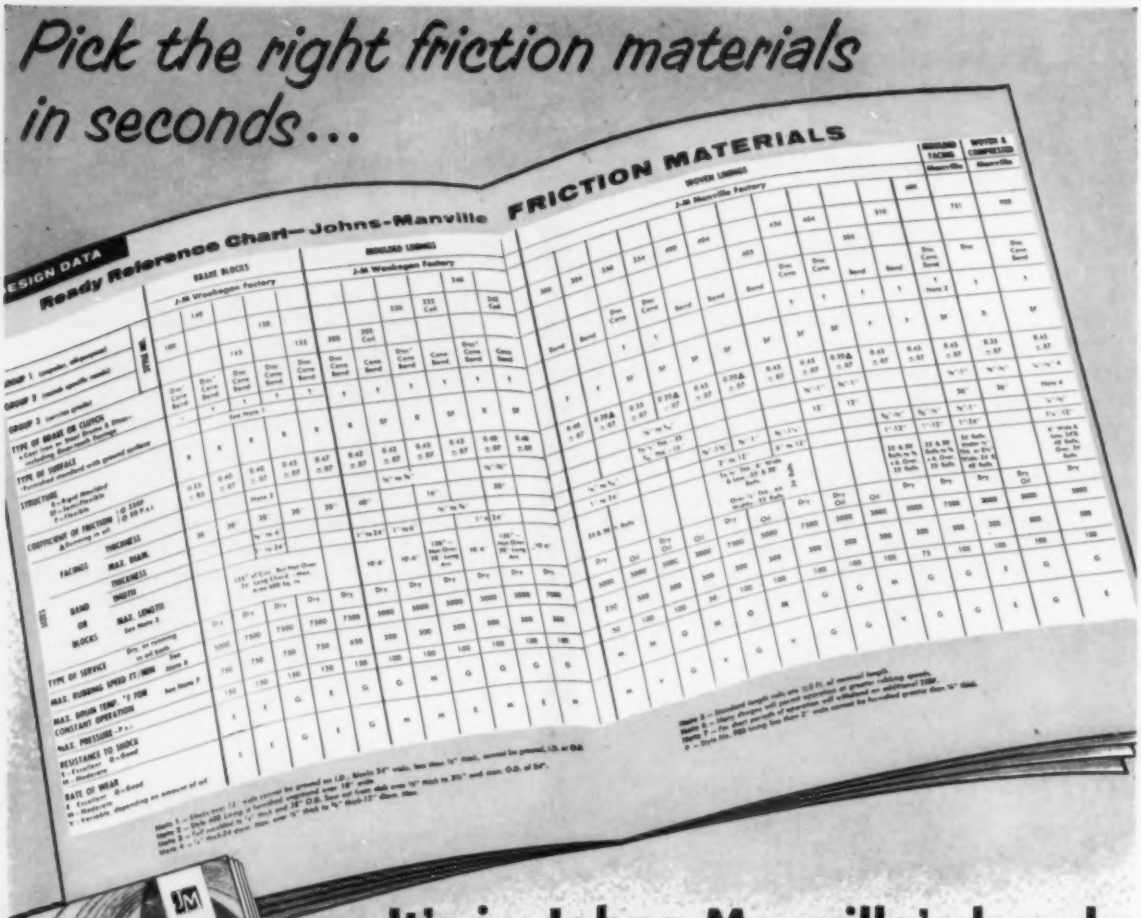
American Felt Company

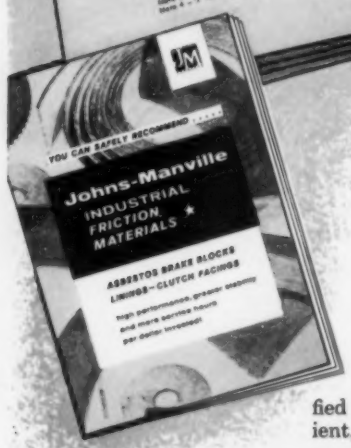
TRADE MARK

GENERAL OFFICES: 78 GLENVILLE ROAD, GLENVILLE, CONN.

SALES OFFICES: New York, Boston, Chicago, Detroit, Cleveland, Rochester, Philadelphia, St. Louis, Atlanta, Greenville, S.C., Dallas, San Francisco, Los Angeles, Portland, San Diego, Seattle, Montreal.—PLANTS: Glenville, Conn.; Franklin, Mass.; Newburgh, N. Y.; Detroit, Mich.; Westerly, R. I.—ENGINEERING & RESEARCH LABORATORIES: Glenville, Conn.

Pick the right friction materials in seconds...





It's in Johns-Manville's handy new Friction Materials Selector

WHEN YOU ENCOUNTER a design problem that involves the control of motion, you'll find this new, ready-reference book about Johns-Manville Friction Materials a big help. Its sixteen pages are loaded with specific design data, presented in simplified table form, that you'll find convenient, accurate and easy to use.

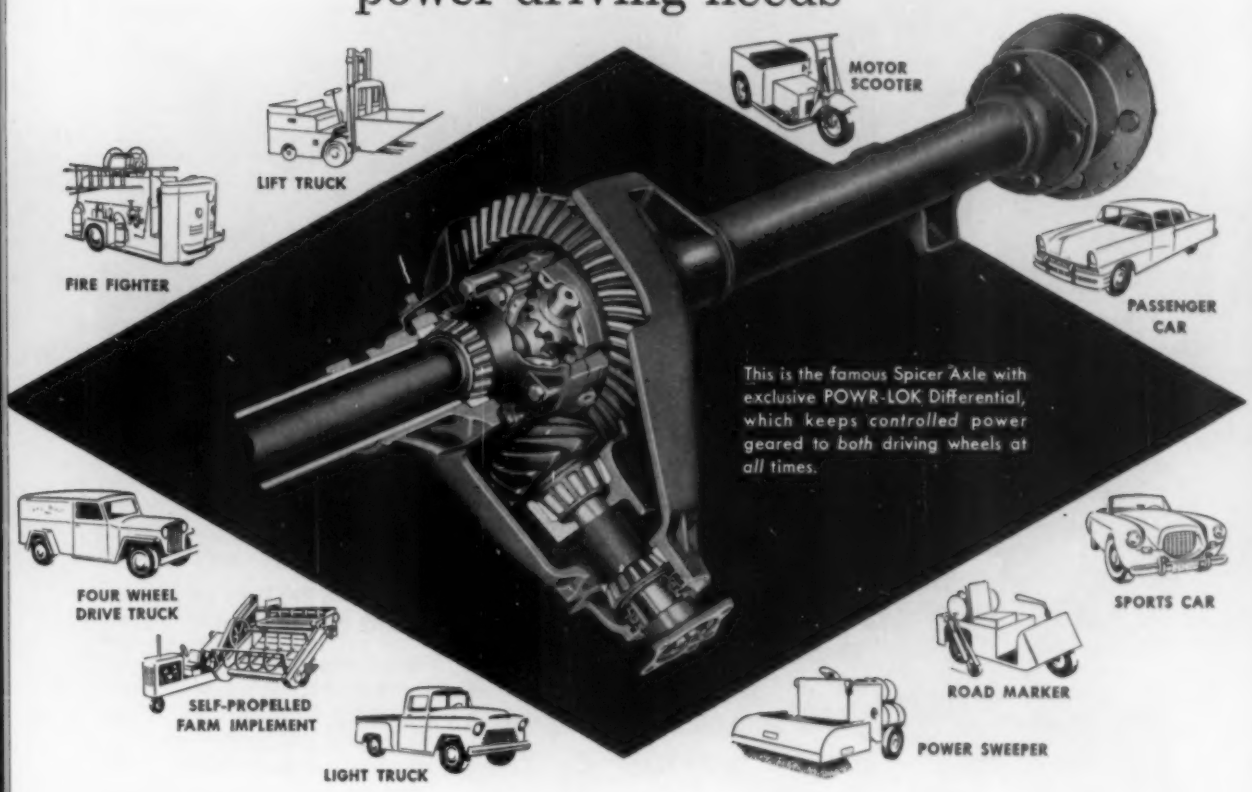
Whether you require a disc, cone, band, block or lining—for application in wet or dry service, heavy or light duty, slow or high speed operation, light or heavy pressure—this book will give you performance characteristics, available sizes and shapes, dimension data and tolerances.

Whatever your problem dealing with the control of motion the J-M Friction Material specialist . . . backed by unmatched J-M Research facilities . . . is at your service. Write Johns-Manville, Box 14, New York 16, N.Y., for your free copy of the Friction Materials Guide—FM35A. *In Canada, Port Credit, Ont.*

JM PRODUCTS

Johns-Manville *Industrial* FRICTION MATERIALS

DANA can design and manufacture efficient Spicer axles to meet your special power-driving needs


MOTOR SCOOTER
LIFT TRUCK
FIRE FIGHTER
PASSENGER CAR
This is the famous Spicer Axle with exclusive POWR-LOK Differential, which keeps *controlled* power geared to *both* driving wheels at *all* times.
FOUR WHEEL DRIVE TRUCK
SPORTS CAR
SELF-PROPELLED FARM IMPLEMENT
ROAD MARKER
LIGHT TRUCK
POWER SWEEPER

DANA can help you adapt stock Spicer Axles and Differential Assemblies to your particular needs.

DANA has available and in production a wide range of axles for such units as:

Light and Medium Duty Trucks	4-Wheel Drive Vehicles
Passenger Cars	Mine Cars
Road Markers	Fire Fighters
Power Sweepers	Lift Trucks
Golf Carts	Self-Propelled Agricultural Vehicles
Motor Scooters	Small Delivery Trucks

and many other specialized types of vehicles.

DANA can help you with over 52 years of power transmission experience . . . with the most diversified corps of engineers in the industry . . . with the industry's largest group of production facilities.

DANA can help you by developing specialized Spicer Axles to solve any unusual problems.

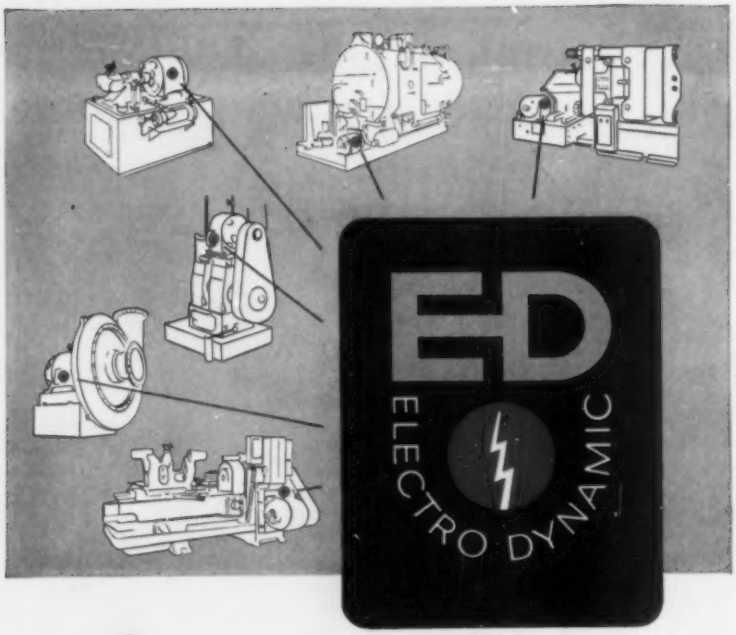
Write for Spicer Axle Engineering Bulletin No. 364, and ask for an engineering conference on your particular axle requirements. We can supply your needs . . . quickly and efficiently.

DANA CORPORATION
Toledo 1, Ohio

SPICER PRODUCTS: Transmissions, Universal Joints, Propeller Shafts, Axles, Torque Converters, Gear Boxes, Power Take-Offs, Power Take-Off Joints, Rail Car Drives, Railway Generator Drives, Stampings, Spicer and Auburn Clutches, Parish Frames, Spicer Frames, Forgings

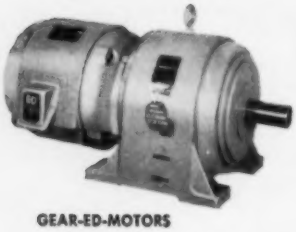
Spicer

Experience in Engineering *Ability in Manufacturing*



STANDARD MOTORS

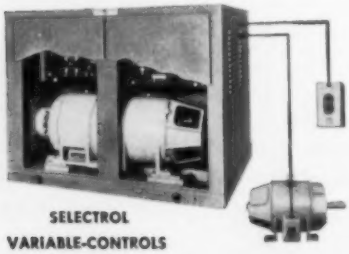
THIS EMBLEM IDENTIFIES EXTRA DEPENDABLE INDUSTRIAL MACHINERY



GEAR-ED-MOTORS

The red *power spot* on industrial machinery means "Powered by Electro Dynamic." Such machinery relies with confidence on the *extra dependability* of Electro Dynamic motors, the proven industrial motors which give industrial equipment *extra dependable* operation.

SELECTRON VARIABLE-CONTROLS



SELECTROL VARIABLE-CONTROLS

NEW...

Write for Brochure 50 and literature on new E.D. motors and drives.

Electro Dynamic division of General Dynamics Corporation Bayonne, New Jersey

ELECTRO DYNAMIC
xtra dependable motors

GD

pump liquid is retained in the casing to reprime the pump the next time it is started. These pumps are furnished in bronze, with bronze impellers and guide vanes. Four non-vapor-locking models are available with electric motor power supplies ranging from ½ to 5 hp, capacities up to 120 gpm for suction lifts up to 25 ft and heads up to 135 ft. Goulds Pumps, Inc., 19 Black Brook Road, Seneca Falls, N. Y.

For more information—
Circle 74, inside back cover

Switch Protects Liquid Systems

Low pressure cut-off switch for water and other liquid system protection stops pump operation when pressure falls below a safe, predetermined operating level. Pumps and water-cooled motors are protected when water level drops below intake of drop pipe and operating pressure falls to cut-off point.

The switch is rated at 1 hp, 110-220 volts a-c. Each switch is preset at the factory to cut-out at approximately 5 or 6 lb. Furnas Electric Co., 1000 McKee St., Batavia, Ill.

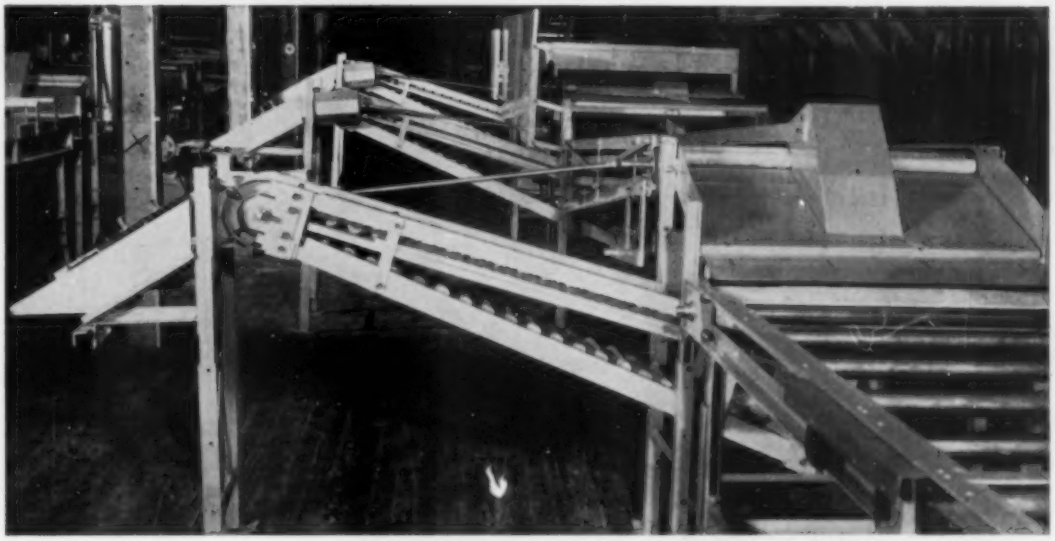
For more information—
Circle 75, inside back cover

Pressure-Sensitive Teflon Tape

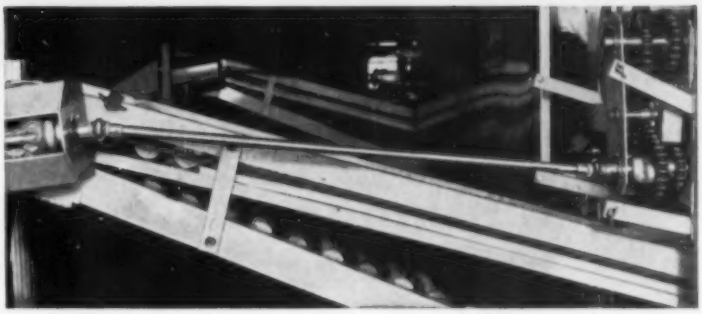
Cementable Teflon tape, in practically any desired thickness from 0.0005 to 0.060 in. and in widths from ½ to 12 in. has one surface treated so that it can be bonded to glass, steel, aluminum, plastics or other material. Polyvinyl ether resins are used. Using the 1-in. standard peel back test, the tape will average 3 to 8

(Continued on page 275)

Here's one more reason for specifying APEX covered universal joints!



Potatoes and onions are cleaned, sized, sorted and packed—in one complete operation—on this unit. Two Apex covered universal joints are installed on each of the three side delivery tables which extend from the left of the unit.



Apex covered universal joints shown in position at ends of 6-foot drive from main unit to delivery table. Joints automatically compensate for adjustment of table height to maximum of 15".

The *covered* universal joint—an exclusive Apex development—has always been the logical choice for applications where joints must operate in liquids, gases, corrosive atmospheres or extremes of temperatures. On such applications, the lubricant-retaining cover protects the joint and assures clean, sustained lubrication.

But manufacturers of food handling and processing equipment have still another reason for choosing Apex *covered* universal joints: controlled lubrication. On this type of equipment, absolute cleanliness is a basic requirement. Here, the cover assures clean, sustained lubrication and, in addition, restricts the lubricant to the joint, eliminating any annoying or harmful oil spray.

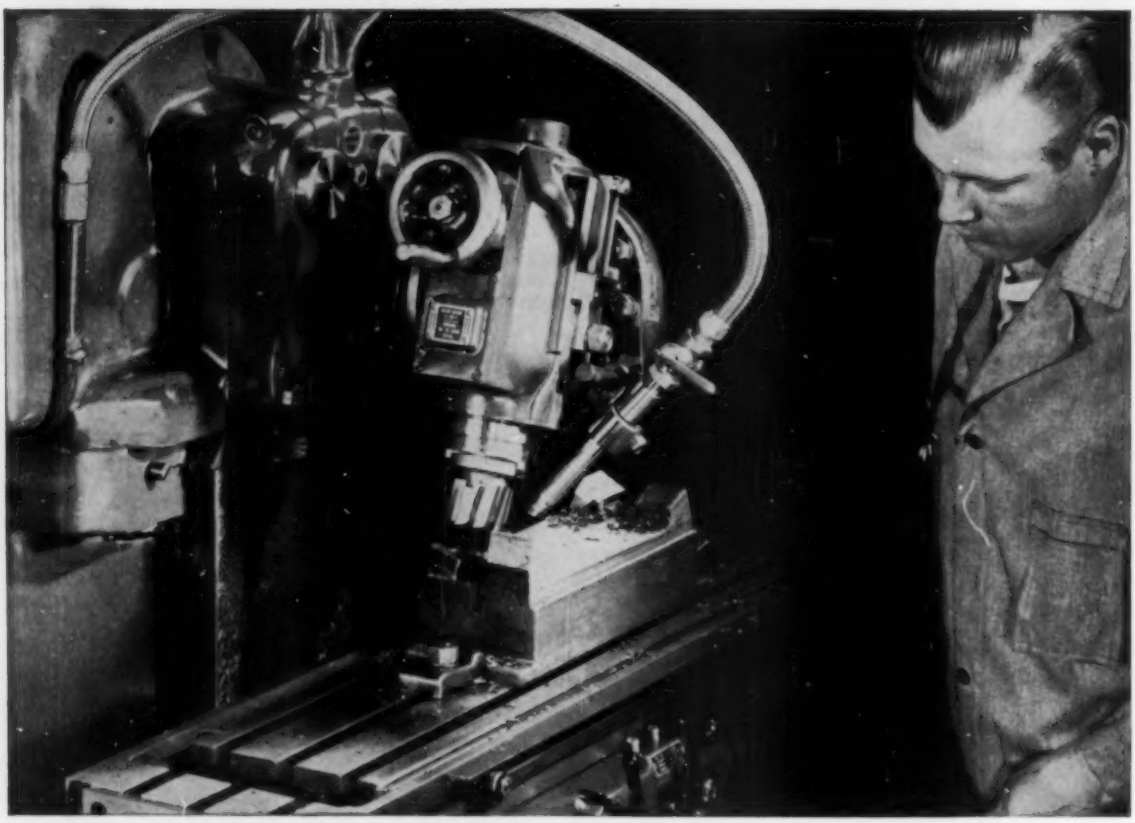
There are many reasons for specifying Apex universal joints and universal joint assemblies, one of the more important being the creative engineering and specialized manufacturing experience that Apex offers. We suggest you write now—on your company letterhead please—for your copy of Catalog 27 and the very helpful Application Data Sheets.

APEX

industrial universal joints—3/8" to 4" diameters

THE APEX MACHINE & TOOL COMPANY
1039 S. Patterson Blvd. • Dayton 2, Ohio

MALLORY·SHARON reports on TITANIUM



The titanium parts you design can be readily machined

• Titanium offers outstanding design advantages—a high strength-to-weight ratio, and exceptional resistance to corrosion in media where many other metals are useless. These advantages can now be realized without paying a penalty in production time.

Present grades of unalloyed titanium machine similar to 18-8 stainless steel. The alloy grades machine somewhat harder but do not approach the difficult-to-machine high temperature alloys. For the usual industrial application of titanium, where corrosion resistance is the major advantage sought, the readily-machined unalloyed grades are usually the best choice.

Mallory-Sharon guarantees that MST titanium and titanium alloy mill products contain no more than 1/10 of 1% carbon. This avoids the formation of hard carbides which greatly reduce machineability.

For bulletin on titanium machining recommendations, please write Dept. P-3.

MALLORY-SHARON TITANIUM CORPORATION, NILES, OHIO

MALLORY Ti SHARON

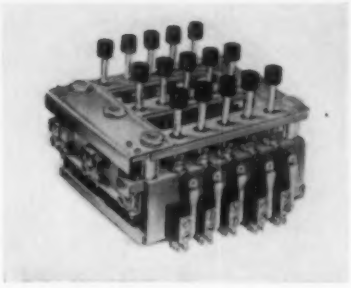
lb per linear inch. Normally furnished in a standard width of 1 in. and a thickness of 0.015 in. Cut-to-size sheets also can be furnished to order. Enflo Corp., Route 38 at Airport Circle, Pennsauken, N. J.

For more information—
Circle 76, inside back cover

Cold Punching Laminate

A paper-base phenolic laminate is said to punch clean and sharp at room temperature. It is especially recommended for copper-clad laminates used in printed circuitry. It is available in plain sheet form or copper clad. Size: 36 x 36 in. sheets, 1/32 to 1 in. thick. Synthane Corp., Oaks, Pa.

For more information—
Circle 77, inside back cover



Interlocking Pushbutton Switches

Mounted in parallel row assemblies to provide a maximum number of interlocked stations, these switches are available in two models, with up to 36 or 24 interlocking stations. Each station may be equipped with various contact combinations, rated 3 or 5 amp, 110 v a-c (non-inductive). Donald P. Mossman, Inc., Brewster, N. Y.

For more information—
Circle 78, inside back cover

Solenoid Valves, 1/2 to 2 In.

This solenoid valve provides independent controls for manual opening, and adjustment of flow, opening and closing speed. It can be mounted on piping running at any angle. It is designed for filling operations, hydraulic systems and elevators.

(Continued on page 276)

PRECISION
PRESSURE REGULATORS

14 models to meet almost all industrial needs.
Send for free catalog.

GOVERNAIRE-pilot operated
KENDALL-direct acting

Now available from the Stratos Industrial Products Branch are two complementary lines of pneumatic pressure regulating valves. Both lines are designed for dead end service. Relief is built in and air consumption is low.

The Governaire: Offering very high flows regulated by small signals, the "Governaire" models are self-contained pilot operated, giving precise control even at very large flow rates. (Illustrated is the lever-operated Model 3500).

The Kendall: Direct acting, force balanced types, the "Kendall" regulating valves also are available in a wide flow range. They offer the reliability in the direct acting type that the "Governaire" models give in the pilot-operated type.

All models can be completely serviced – including replacement of working parts – without removal from the line. Most are designed for operation at up to 250 psi supply pressure.

AVAILABLE MODELS

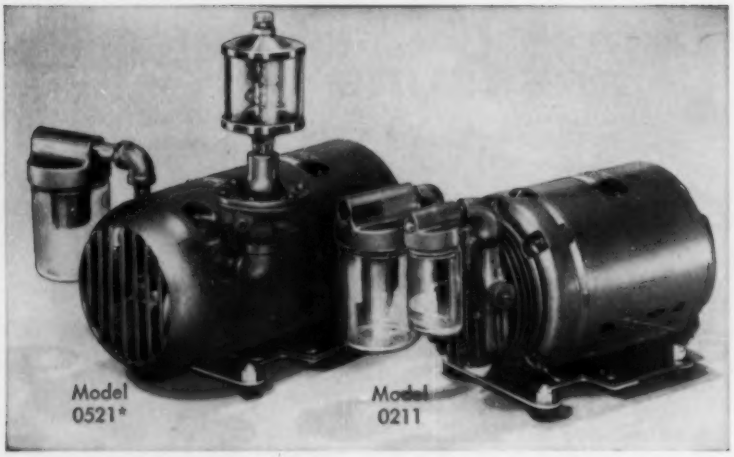
GOVERNAIRE

Regulators Model No.	Regulated Pressure Range	Pipe Sizes
1000	½–10 to 2-150	¼ & ⅜ NPT
3500 (Drift-free Lever Set)	½–30 to 3-150	⅜, ½ & ¾ NPT
4000	½–10 to 5-250	⅜, ½ & ¾ NPT
Volume Boosters		
1500 (spring biased)	½–10 to 2-150	⅜, ½ & ¾ NPT
	Ratio	
2000	1:1	¼ & ⅜ NPT
4500	1:1, 1:2, 1:3 2:1 & 3:1	⅜, ½ & ¾ NPT
2500 (reversing relay)	1:1 & 1:3	½ & ¾ NPT

KENDALL

Regulators Model No.	Regulated Pressure Range	Pipe Size
10	½–30 to 2-150	¼ & ⅜ NPT
30 (miniaturized)	½–30 to 2-100	¼ & ⅜ NPT
50	20 psi set	¼ NPT
55	0–10 to 2-100	¼ NPT
Volume Boosters Model No.	Range	Pipe Size
15	0–10 to 2-150	¼ NPT
	Ratio	
20	1:1, 1:2, 1:3 2:1 and 3:1	¼ NPT
25 (reversing relay)	1:1	¼ NPT

STRATOS
INDUSTRIAL PRODUCTS BRANCH
A Division of Fairchild Engine and Airplane Corporation
Route 109, West Babylon, Long Island, N. Y.

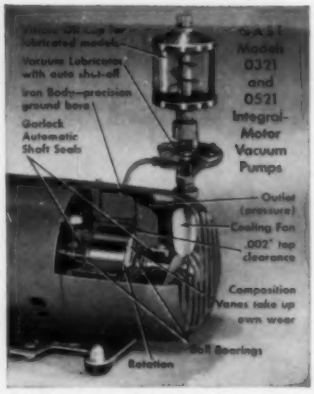


Get 10 Integral-Motor-Pump advantages in two NEW types (three models) of

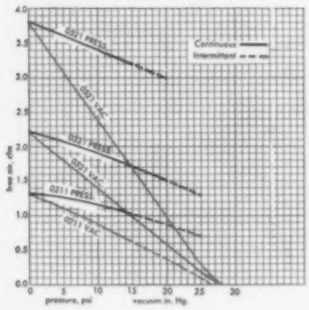
GAST rotary vane AIR PUMPS

Designers seeking a dependable vacuum or pressure source for industrial instruments, vending machines, air gauge circuits, air sampling, laboratory equipment, printing and packaging machinery, etc., will find these *new* Gast Integral-Motor Air Pumps highly advantageous, especially where compactness and portability count. Consider these outstanding features:

1. Latest type G.E. "Form G" motors.
2. More compact than any pump of equal capacity.
3. Total weight reduced ⅓—cuts shipping costs.
4. Motor mounting time and labor eliminated.
5. Simple, trouble-free rotary-vane design.
6. Vanes take up their own wear automatically.
7. Positive displacement, pulseless air delivery.
8. Improved appearance—smoother exterior.
9. Dependable for original equipment; plant use.
10. Forced air fan cooling on Models 0321 & 0521.



Performance-Vacuum & Pressure



Write for new Bulletins V-356 and P-356!
GAST MANUFACTURING CORP.,
P. O. Box 117-V Benton Harbor, Mich.

*0321 similar in appearance.

Original Equipment Manufacturers for Over 25 Years

GAST ROTARY

- AIR MOTORS TO 4 H.P.
- COMPRESSORS TO 30 P.S.I.
- VACUUM PUMPS TO 28 IN.

SEE OUR CATALOG IN SWEET'S PRODUCT DESIGN FILE

Valve is available in all standard sizes, from ½ to 2 in. Present maximum capacity is 300 psi. J. D. Gould Co., 4707 Massachusetts Ave., Indianapolis 18, Ind.

For more information—
Circle 79, inside back cover

Sub-Fhp Motors

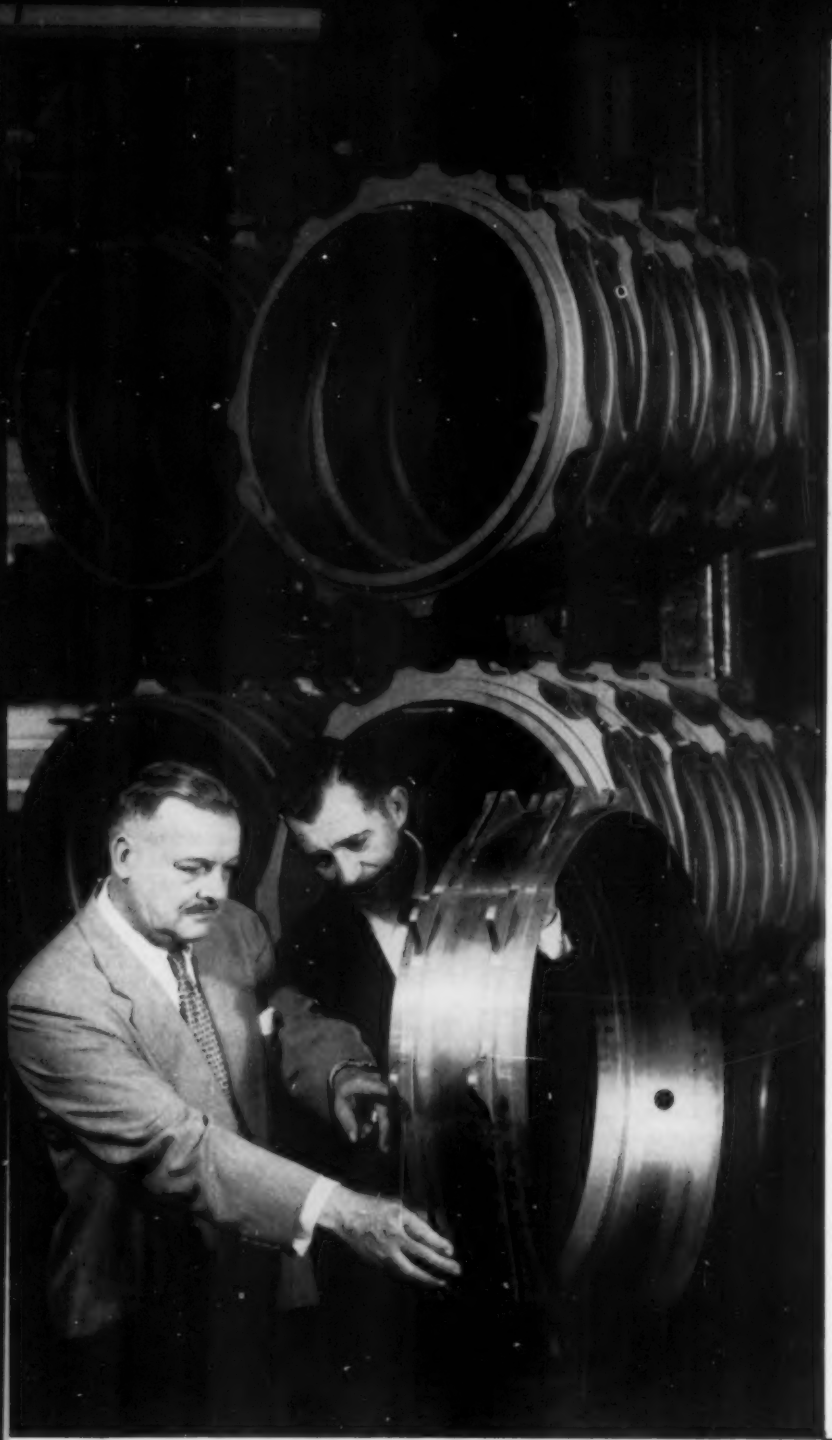
These motors are offered in a range of 1/2000 to 1/750 hp and are available in both synchronous and induction types, with or without gear trains. End bells and gear train cases are die-cast alloys. Geared output shafts have two bearing supports. George W. Borg Corp., Jamesville, Wis.

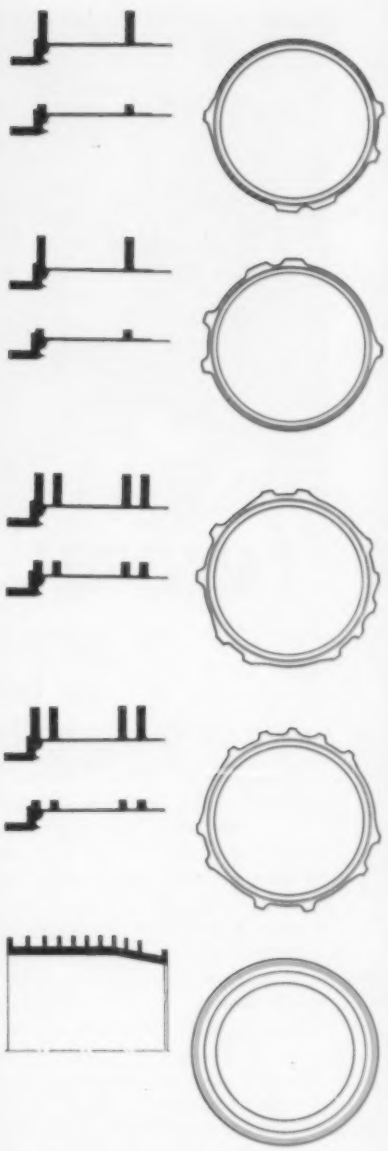
For more information—
Circle 80, inside back cover

Test Jack

Beryllium copper spring pin contact accepts standard 0.080 in. dia test probe. A nickel-plated brass mounting bushing provides secure mounting un-

(Continued on page 278)





Typical ring sections and profiles showing lug configurations in a smaller scale.

STAINLESS STATOR RINGS

One of Cameron's most interesting contributions to military and commercial air-power today is the production of forged, stainless steel, stator rings. Our unique processes make possible precision forgings with odd lug configurations, large diameters and a vastly superior grain structure. Shapes and sizes heretofore costly to produce as a forging are now sound economy at Cameron.

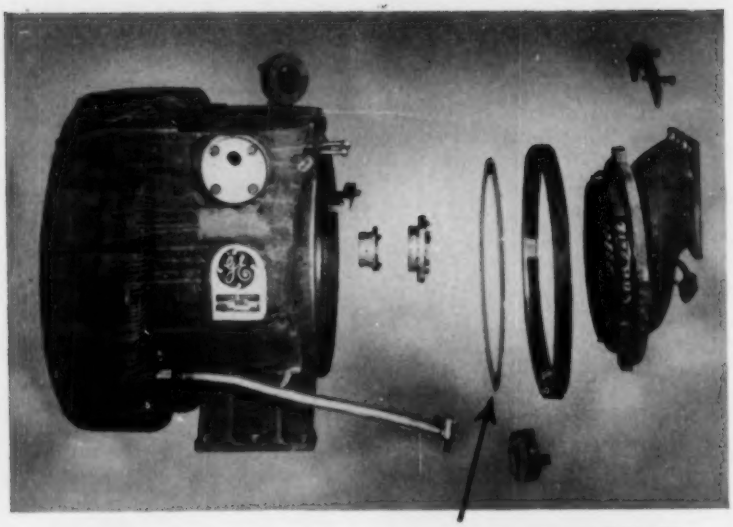
The study of specialized alloys to meet the extreme demands of today and to anticipate those of tomorrow parallels forging production and is a part of our progress.

Investigate these advantages — write or call .....

Cameron

IRON WORKS, Inc.

SPECIAL PRODUCTS DEPARTMENT
P. O. Box 1212, Houston, Texas



LAMINUM® adjustable SHIMS

cut assembly costs on turbo-supercharger for diesel engines

THIS is only one from thousands of laminated shim applications throughout all industry. Yet the reason for using laminated shims and the gains resulting are typical. This shim sets the clearance between the nozzle and buckets on the General Electric RD3C turbo-supercharger. Shimming is essential because of the accumulation of tolerances. The laminated shim can be adjusted quickly merely by peeling—and after peeling is always precisely uniform in thickness from end to end and side to side. Peeling is far easier and faster than precision grinding which would prove quite costly on these extremely large shims.

Whenever you need shims, call the Laminated Shim Company *first*...for fast, complete service. We manufacture shims in aluminum, brass, steel—small as a fingernail and large enough for locomotives...laminated, spot-soldered or looseleaf. Produced to your own precise blueprint specifications.

For further information and free booklet telling all about laminated shims and how they're used, please write. No cost or obligation, of course. Write today!

SHIM HEADQUARTERS SINCE 1913

LAMINATED SHIM COMPANY, INC.

The name Laminum is registered with U. S. Patent Office

1412 UNION STREET, GLENBROOK, CONN.

LAMINATED SHIMS OF LAMINUM® AVAILABLE IN BRASS • STEEL • STAINLESS STEEL • ALUMINUM

der extreme conditions of shock and vibration. The contact assembly is silver plated with gold wash. The nylon insulator is available in nine brilliant colors for visual circuit identification. Raytheon Mfg. Co., Waltham 54, Mass.

For more information—
Circle 81, inside back cover

Self-Contained Meter

This meter requires the panel space of a 1½ in. meter, yet it is said to provide scale length and readability of a standard 2½ in. round meter. All necessary rectifiers, associated resistors and shunts are contained within the instrument housing. The meter is interchangeable with standard 1½ in. JAN types. Marion Electrical Instrument Co., Grenier Field, Manchester, N. H.

For more information—
Circle 82, inside back cover

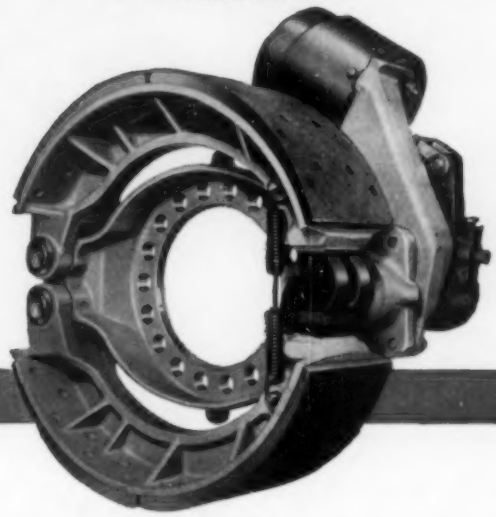
Subminiature Servo Motor

With dimensions of ⅝ x 1 in. long (plus shaft extension), this motor weighs under 1 oz. It operates on 26 v, 400 cps, with a control voltage

(Continued on page 282)

TDA® BRAKES

if it rotates...we can control it!



Better control for the "heavyweights"

NEW TIMKEN-DETROIT® HEAVY-DUTY "P" SERIES POWER BRAKES

Dependable control is indispensable on *all* big construction vehicles. Manufacturers must provide brakes that are big, rugged, safe and durable.

Timken-Detroit Brake Division now makes available the new Heavy-Duty "P" Series Brakes to offer manufacturers greater dependability . . . *better* control . . . and *longer* service.

The Heavy-Duty "P" Series Brake utilizes a unit-mounted design offering a self-contained, compact assembly. Camshaft and air chamber support brackets are mounted directly onto the brake spider. (Inboard chamber mounting design is also available.)

Temperatures during operation are lower and liner life is longer because of the open-type spiders which assure good internal ventilation and rapid cooling. Timken® ¾" "Econo-liners" are tapered to provide greatest thickness where most wear occurs . . . less waste material at reline.

Other features include: heat-treated, malleable iron brake shoes . . . securely riveted brake linings . . . constant lift S-type, heat-treated cam . . . sealed, needle bearing camshaft mountings . . . long-life bronze bushings in anchor-pin holes . . . hardened, rust-proofed anchor pins.

Heavy-Duty "P" Series Brakes are available in a complete range of capacities and sizes to fit every Heavy-Duty operating requirement.

For every industrial, agricultural or automotive application where braking is required!

TIMKEN Detroit BRAKES
ROCKWELL SPRING AND AXLE COMPANY
Accepted TDA Standard

TDA plants at: Detroit, Michigan • Oshkosh, Wisconsin • Utica, New York Ashtabula, Kenton and Newark, Ohio • New Castle, Pennsylvania

©1956, RS&A Company

Timken-Detroit Brake Division
Rockwell Spring & Axle Company
Dept. PE-126, Ashtabula, Ohio

Please send me further information on your "P" Series Brake.

Name _____
POSITION

Company _____

Address _____

City _____ State _____

TAYLOR Laminated Plastics Vulcanized Fibre

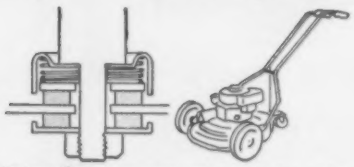
Shop Talk

TAYLOR FIBRE CO.

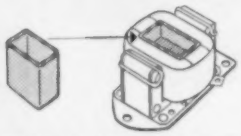
Plants in Norristown, Pa. and La Verne, Calif.

PHENOL—MELAMINE—SILICONE—EPOXY LAMINATES • COMBINATION LAMINATES • COPPER-CLAD LAMINATES • VULCANIZED FIBRE

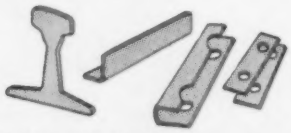
Tips for designers



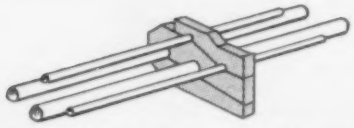
Rotary lawn mower utilizes abrasion resistance of Taylor phenol laminate washer in slip-clutch attachment of drive shaft to cutting blade.



Coil forms for this solenoid have to operate at high temperatures . . . an ideal application for Taylor glass melamine laminates.



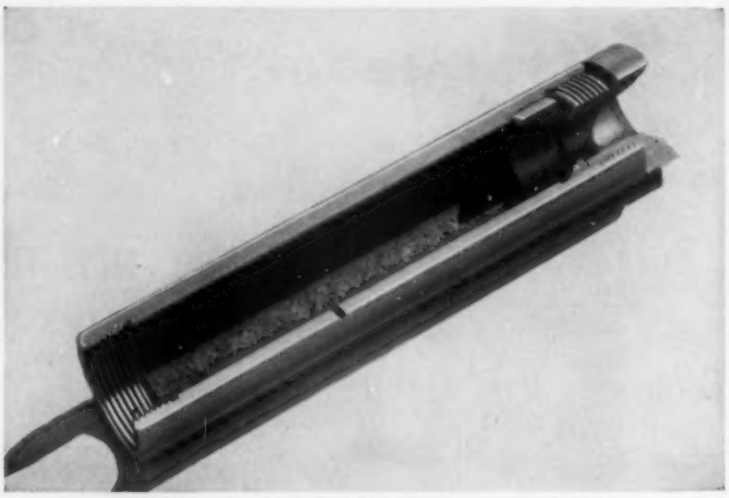
Railroad track-joint insulation, a specially developed grade of Taylor vulcanized fibre, withstands heavy impact and mechanical stress of high-speed trains.



Fuel-line clamp for a fighter plane's "pipeline" system is machined from Taylor fabric base laminate which has high mechanical strength and resists extreme temperature and humidity.

NEW TAYLOR
COPPER-CLAD LAMINATES

Taylor GEC (glass-epoxy) Copper-Clad and Taylor XXXP-242 cold punching (paper-phenol) Copper-Clad. Taylor uses high purity rolled copper on base materials with outstanding electrical properties.



Fuse holder used in power lines for underground trolley service is machined to extremely close tolerances from Taylor Grade XX tubing.

Make strong insulated parts

. . . from TAYLOR *laminated tubes and rods*

These rugged, readily machined materials make outstanding electrical or mechanical components—at substantial savings in fabrication, assembly, and material costs. Taylor Laminated tubes and rods are the logical choice wherever specifications call for mechanical strength, heat resistance, and electrical insulation.

Taylor tubes and rods are made in many paper, fabric, and glass-base grades, with special formulations of phenol, silicone, melamine, or epoxy resins. Within the complete line the designer and the production man can find a variety of combinations of electrical and physical properties for a broad range of product applications.

Taylor tubes and rods are standard products. Tubes are available with inside diameters as small as three thirty-seconds of an inch . . . rods with diameters from one-sixteenth of an inch.

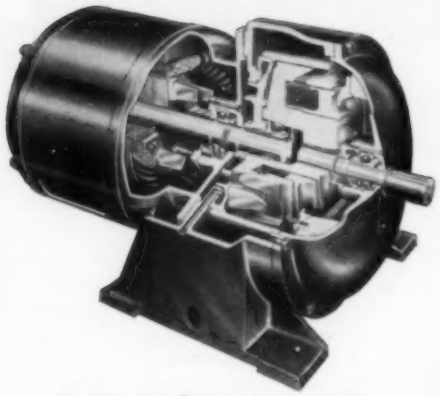
A Taylor sales engineer will be glad to help you select the grade and size of laminated tubes or rods to match the exact requirements of your application. And, you can eliminate many purchasing, stocking and manufacturing problems by having the Taylor Fabrication Division produce finished parts to your specifications. Call your nearest Taylor sales engineer for a discussion of your specific needs.

No Commutators, No Rings, No Brushes, No Rotating Coils—in the NEW

EATON

DYNAMATIC®

Adjustable Speed Drives



Dynaspede® Stationary Field Coupling, with Integral Motor

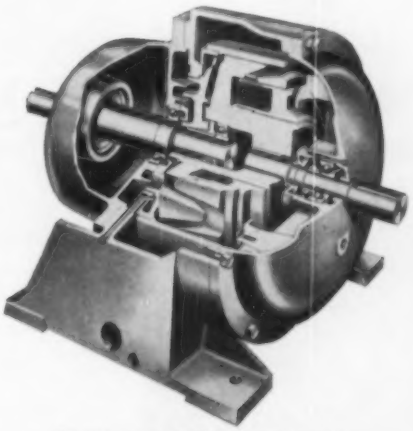
Dynamatic stationary field couplings are the simplest drives so far devised to provide infinitely adjustable speed from an alternating current source. The absence of rotating coils, brushes, slip rings, and commutators in this design holds wear and maintenance to an absolute minimum. Dynamatic electronic or magnetic amplifier controls, in combination with these drives, provide wide latitude in operating functions.

Check these Outstanding Advantages:

Accurate speed control • Wide speed range • Low power losses • Simple construction • Rapid response • Remote control • Quiet, efficient operation • Low maintenance costs

Ajusto-Spede® Drives: Air cooled, stationary field eddy-current couplings mounted integrally with D-flange open drip proof squirrel cage motors are available in capacities from 1 to 75 HP. Units of the same design and capacities are also available without motors.

Dynaspede® Drives: Liquid cooled, stationary field couplings mounted integrally with D-flange squirrel cage motors are available in capacities from 3 to 75 HP. Motor types available are drip proof, splash proof, totally enclosed fan cooled, and explosion proof. The coupling is totally enclosed. Separately mounted couplings are also available in capacities from 3 to 2500 HP and larger.



Stationary Field Coupling for use with Separately Mounted Motor

Send for Detailed Information on these New Stationary Field Couplings and Drives

EATON MANUFACTURING COMPANY
DYNAMATIC DIVISION
3307 FOURTEENTH AVENUE • KENOSHA, WISCONSIN

The
TIMER RELAY
that eliminates controlled timing problems

★ No false contacts
★ Non sticking
★ Practically "fail safe"
★ Low cost timer

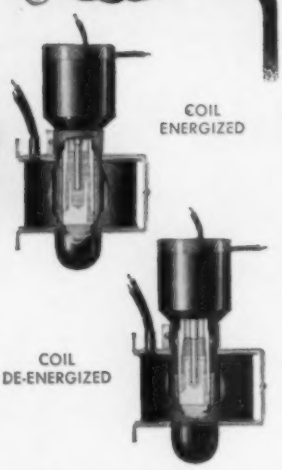
1926 20th ANNIVERSARY 1956
DURAKOOL

Durakool
STEEL MERCURY TIMERS

This steel clad, factory set, tamper proof Durakool timer-relay is practically non-breakable. Operating life multiplied 5 to 6 times by new plunger construction features. Any combination of operate-release time delays from 0.15 sec. to 20 sec.— either normally open or normally closed action.

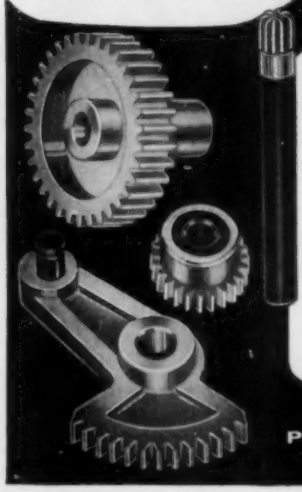
See telephone directory for local distributor, or write.

DURAKOOL, INC.
ELKHART, INDIANA, U.S.A.
700 WESTON RD., TORONTO 9, CANADA



Send for Bulletin 800

NOW!
new economies in NYLON GEARS
means savings in gear costs up to 90%



Our many years of pioneering and successful production of Nylon Gears, plus new reduced mold charges, can now make even greater economies for you in the use of Nylon Gears. With the great variety in molds now possible, Nylon should not only be considered as an economy measure but the answer to many problems where a compact design is necessary. Nylon Gears are quiet, durable, efficient and need less lubrication – they mate perfectly with metal gears.

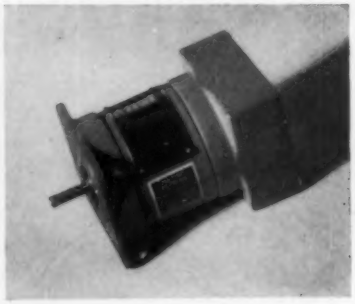
Let our engineers with more than a decade in gear experience show you how Nylon Gears can save you money – let us consider your gear problems during the design process–send blueprints or specs for prompt estimates.

105

PROCESS GEAR CO., INC.
4602 W. Fullerton • Chicago 39, Illinois

range of 0 to 26 v. Typical characteristics includes: 2½ w input, 1/10 w output, 0.063 in.-oz stall torque; 8800 rpm no-load speed. Temperature range is −75 F to 200 F. This motor is available with smooth or splined shafts. Ford Instrument Co., Div. Sperry Rand Corp., 31-10 Thomson Ave., Long Island City 1, N. Y.

For more information— Circle 83, inside back cover



Torque-Brake Unit

Designed to provide continuous tension, these motors are especially applicable to wire winding. Torque can be decreased by reducing the applied voltage or increased if intermittent ratings are permissible in the application. B. A. Wesche Electric Co., 1622 Vine St., Cincinnati 10, Ohio.

For more information— Circle 84, inside back cover

Heat-Resistant Silicone Finish

This silicone resin copolymer can be baked in 30 min at 400 F. The resulting SR-120 film can withstand continued exposure up to 440 F and may be pigmented or obtained in a wide variety of colors. General Electric Co., Waterford, N. Y.

For more information— Circle 85, inside back cover

Sheet Metal Fastener

Ranging in thread sizes from No. 2 through 10, flush mounting is obtained with sheet thickness as low as 0.035 in. Nut is locked in parent sheet both radially and axially in order to develop full strength of mating

(Continued on page 285)

main valve seat for fire plug

Sand-cast pegs bent easily, causing improper fire plug operation. Full line pressure could not be maintained. Machining often uncovered blow-holes causing rejects. Switched to brass forging for higher strength, dense structure, closer tolerances, reduced over-all costs.

quick-acting fuel coupling

To enhance its reputation for quality and to assure tightness under pressure, Ever-Tite Coupling Company turned to forgings for quick couplings used to transfer petroleum and other liquids. Because of the abuse to which this type of equipment is subjected, forgings offer unexcelled performance.

base for TV signal transmission

Porosity and blow-holes in sand-cast part caused "high standing wave," or loss of power feeding into TV transmitting tower through base on end of cable. This required tearing down whole assembly at considerable cost. Switch to dense, strong forging eliminated rejects and power leakage.

water meter lid and register box

Lid converted from sand casting to brass forging. Register box from sand casting to pressure die casting. Weight reduced greatly on both — thus lowering costs. Closer tolerances after change eliminated costly machining on the box.

Vital Change

from sand castings to brass forgings

Titan

METAL MANUFACTURING COMPANY

Bellefonte, Pa. Offices and Agencies in Principal Cities

Titan brass forgings are more easily drilled, tapped, broached and milled than are sand castings. Fewer machining rejects result. Forgings are hot-pressed quickly, are denser, tougher and stronger. Moreover, brass forgings have a smooth beauty and warmth not obtainable in sand castings. Scrap is reduced. Some machining operations necessary on sand castings are actually eliminated by switching to accurate-dimensioned forgings. Getting down to brass tacks, what this means to you is lower costs and a better product by switching to Titan hot-pressed brass forgings.

Send us a sample, drawing, and production quantities of sand-cast assembly parts you now use. We'll quote you on changing to brass forgings.

If you want more data on Titan brass forgings, send coupon below:

Dept. R.

Titan Metal Manufacturing Co., Bellefonte, Pa.

Gentlemen:

- ☐ Will send sand-cast part and details for you to quote as brass forging
- ☐ Please send further data on Titan brass forgings
- ☐ Have Titan representative call

Name_____ Title_____

Company_____

Address_____ City & State_____

Quality Alloys by Brass Specialists

MORE EFFICIENT DESIGN, IMPORTANT SAVINGS, SIMPLIFIED ASSEMBLY, BETTER APPEARANCE

These are some of the many benefits reported by Design Engineers who have adopted TRU-LAY PUSH-PULLS for remote control operations on literally hundreds of products

Here are typical comments recently received from equipment manufacturers whose machines or implements are equipped with these accurate and dependable remote controls:

Saves Time, Labor and Material
"The use of your flexible Push-Pulls saves us a great deal of time, labor and material. The old linkages frequently required much planning in both engineering and shop which is not required now. On some of our equipment we use Push-Pulls from 10 to 30 feet in length. They operate clutch controls on the Main Power Unit, Feed Conveyors and Delivery Conveyors."

Greater Flexibility of Design
"The principal advantage of Tru-Lay Push-Pulls in our application is that they permit flexibility in locating the control valve in relation to the operator's position."

Cost Less to Install
"Tru-Lay Push-Pulls are easier and less expensive to install than linkages for remote control of power take-off, brake and clutch. Better appearance, too."

Simple and Neat
"For several models of farm tractors, we selected your controls for their simplicity and neatness of application as governor controls."

Solution to Tough Problem
"Can be installed where straight rods are impossible . . . for Remote Control of transmissions, brakes and clutches."

Eliminates Maintenance
"Simple operation and elimination of maintenance problem are the major advantages in using your Push-Pulls."

Reduces Number of Parts
"Your Push-Pulls have eliminated links, radius rods and other lost-motion devices for remote control of hydraulic valves."

Provide ACCURATE Control
"Tru-Lay Push-Pull control cables provide minimum back-lash, even in installations up to 30 feet in length, because the cable is designed to close tolerances with minimum drag and lost motion."

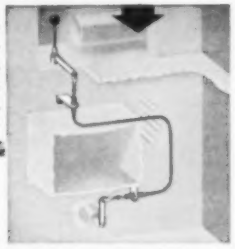
• • •

TRU-LAY PUSH-PULLS are "Solid as a rod but *Flexible* as a wire rope." This flexibility makes it possible to snake around obstructions . . . permits the ideal arrangement of all elements of remote controls.

***Advantages** of Tru-Lay Push-Pull flexibility and simplicity are pictured below—*

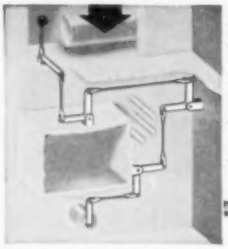
TRU-LAY PUSH-PULL

Simple
One Moving Part
Life-Time Service
Life-Time Accuracy
Low over-all Cost
Noiseless



MECHANICAL LINKAGES

Complex
Many Parts
Many Points of Wear
Increasing Back-Lash
Loss of Accuracy
Vibration
Rattles



Construction Equipment and **Farm Implements** provide good examples of the wide-spread use of these accurate, simple and dependable Push-Pulls. On Power Shovels, Winches, Graders, Road Oilers, Dump Trucks, Snow Plows, Engine-driven Pumps, Crushers, Tractors, Combines, Corn Pickers, Corn Row Sprayers, Corn Detasslers, Orchard Sprayers, Power-driven Tree Trimmers, Tobacco Picking Machines and others . . .

TRU-LAY PUSH-PULLS are operating unfailingly for the remote control of Hydraulic and Air Valves, Brakes, Clutches, Transmissions, Throttles, Chokes, Governors, Power Take-Offs, Spray Nozzles, Vent Directional Fins and on many other applications.

ACCO *Our DATA FILE will answer all further questions*

AUTOMOTIVE and AIRCRAFT DIVISION
AMERICAN CHAIN & CABLE

TRADE MARK

601-E Stephenson Bldg., Detroit 2
2216-E South Garfield Ave., Los Angeles 22 • 929 E Connecticut Ave., Bridgeport 2, Conn.

There is No Worry about Failures or Maintenance Costs with TRU-LAY Push-Pull Remote Controls

Long Life is a matter of record. We have never heard of a Tru-Lay Flexible Push-Pull Control wearing out in normal service. Failures, that sometimes harass users of more complex controls, are eliminated by the use of these simple, positive-action controls.

Dependable Operation of these controls is a certainty, even under the most adverse conditions . . . HOT as jet engines (note: Tru-Lay Push-Pulls are actually performing on hot jet applications) . . . COLD to 70° F below zero . . . SOAKIN' WET . . . ABRASIVE . . . or just plain TOUGH.

Freedom from Trouble is assured because of such features as . . . full protection of the inner, working member by the tough flexible conduit . . . lubrication of the inner, working member *for life* during assembly . . . seals that keep moisture, dust and other foreign matter out of the unit . . . cold swaging of fittings that makes them integral parts of the control unit.

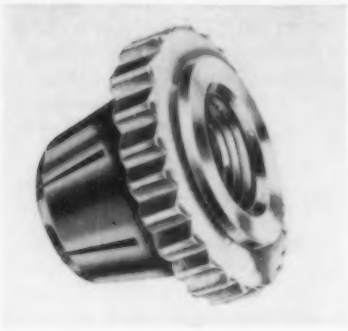
Accuracy is inherent in the basic design of Tru-Lay Push-Pulls. They are precision products, not gadgets.

Capacity ranges from light jobs up to jobs of 1,000 lbs. input. These Push-Pulls will handle jobs 150 feet or more from the control point.

"Solid as a rod, Flexible as a wire rope" aptly describes Tru-Lay Push-Pull Controls. This flexibility provides positive, remote action whether anchorages are fixed or movable . . . it damps out noise and vibration . . . it greatly simplifies installation of controls by reducing the number of working parts and by making it possible to snake around obstructions.

Adaptability to all sorts of mechanical situations explains, in large measure, the wide-spread application of Tru-Lay Push-Pulls. Standard anchorages, fittings and heads have been designed that meet requirements on approximately 80% of the installations. Simple modifications of these standards, or minor changes in your own design, cover almost every special situation. Our engineers have the know-how on such matters, and will work with you.

For Further Information—The DATA FILE pictured at the left contains six booklets and bulletins that will answer any further questions you may have about this versatile and dependable tool. It is quite likely that this material will point the way to a simplified solution of your remote control design problems. **Write for a copy.**



bolt and is made of 303 stainless steel. Rosan Inc., 2901 West Coast Highway, Dept. 29, Newport Beach, Calif.

For more information—
Circle 86, inside back cover

Hinged Lever Switch

Ease of removal or assembly of the lever makes it possible to use standard parts and add secondary operations to the lever to meet special application requirements.

This switch is available in two types which are UL-listed and rated at 15 amp, 125 and 250 v a-c. Detroit Controls Corp., 800 Union Ave., Bridgeport, Conn.

For more information—
Circle 87, inside back cover

Damped All-Metal Mount

For all-positional or all-attitude performance, this mount withstands hours of resonance with input of

(Continued on page 286)

RELY on GI . . .

for smooth, effortless performance, just one of the reasons why manufacturers

SPECIFY GI FRACTIONAL HP MOTORS

MODEL B
4-pole, 4-coil shaded pole AC Induction Type

MODEL A
2-pole, shaded pole AC Induction Type

MODEL C
2-pole, shaded pole AC Induction Type

■ For really smooth, silent operation, GI fractional hp motors have no equal — that's why original equipment manufacturers have been relying on GI 1/40 hp to 1/1100 hp motors for over 25 years. Leading manufacturers have proved to themselves that GI motors are unexcelled in the industry. They appreciate General Industries free design consultation service and prompt deliveries, too. When **you** have a fractional hp requirement, you'll find that your best bet is to — RELY on GI!

Write for complete specifications and quantity-price quotations.

MODEL E
4-pole, shaded pole AC Induction Type

MODEL D
4-pole, 4-coil shaded pole AC Induction Type

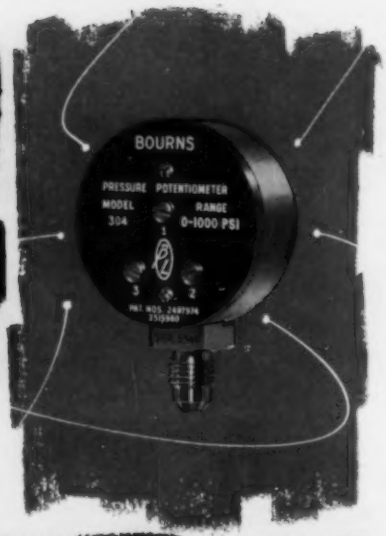
MODEL O
2-pole Capacitor Reversible Type AC only (for 6, 12, or 24 volts)

MODEL F
2-pole, shaded pole AC Induction Type

THE GENERAL INDUSTRIES CO.

DEPARTMENT GK • ELYRIA, OHIO

BOURNS



MODEL 304

GAGE PRESSURE TRANSDUCER

—high performance in miniature size

Only 1⅝" in diameter... ¾" thick, this is an exceptionally small gage pressure potentiometer. Its miniature size and compact configuration permits use in ground and airborne installations—in control telemetering or remote recording circuits—wherever space is at a premium.

Time proved performance. This is a fully integrated instrument built for high reliability under extreme environmental conditions. The dependable Bourns Bourdon tube assembly and linkage system provide exceptional shock, vibration and acceleration characteristics ... linearity and hysteresis are excellent. Units are designed to meet or exceed most government specifications for airborne equipment.

The Bourns Model 304 weighs about 2 ounces. It operates with a high-level AC or DC signal. Pressure ranges: from 0-100 to 0-5000 psi. Three Bourdon tube materials are available:

Beryllium copper—the standard construction—for non-corrosive fluids. Measures air, Freon, oil, and other common media.

Stainless steel—permits corrosive fluids such as fuming nitric acid to be applied within the tube.

Ni-Span-C—provides low temperature error for versatility of application.

Complete data in Bulletin No. 304.

ABSOLUTE AND DIFFERENTIAL PRESSURE

In addition to the Model 304, Bourns manufactures a complete line of high pressure transducers in absolute and differential ranges, for use with corrosive or non-corrosive fluids. Request Bulletin No. 70456.

MODEL 704—differential pressure type with stainless steel Bourdon tube

MODEL 706—differential pressure type with Beryllium copper Bourdon tube

MODEL 705—absolute pressure type for use with clean, non-corrosive media

COPR. BL

BOURNS LABORATORIES

General Offices: 6135 Magnolia Avenue Riverside, California
Plants: Riverside, California—Ames, Iowa

0.036 in. double amplitude. Withstands repeated 15 G shocks without loss of efficiency and 30 G ultimate. Ucinite Co., Newtonville 60, Mass.

For more information—
Circle 88, inside back cover

High Pressure Seals

These seals are designed for shafts which pass through panels or housings, and for rotary switches. The seal consists of a grooved nut, to which is molded a silicone rubber boot. Sealing is accomplished by a gasket-rib, which seats firmly against the panel and two O-ribs which form a double seal against the shaft. A special lubricant permits the seal to function at intermittent speeds up to 3600 rpm.

The silicone rubber will operate at temperatures from −120 F to 500 F. Present models fit ⅛, ¼, ⅜ and ½ in. shafts. Automatic & Precision Mfg. Co., 252 Hawthorne Ave., Yonkers, N. Y.

For more information—
Circle 89, inside back cover

Fan-Cooled Worm Reducers

Reducers are available in sizes from fhp to 450 hp. Rockwood Pulley Mfg. Co., Inc., 20 Crosby St., New York 13, N. Y.

For more information—
Circle 90, inside back cover

Dial Indicator

These 3½-in. concentric dial indicators are primarily intended for use on graphic panels, but may be used in applications where small-sized circular

(Continued on page 288)

Chances are at least **98 out of 100** that this part will be **perfect**

The Metal Stampings Plant, Sylvania Electric Products, Inc., keeps rejects under 2%—even on complex, close-tolerance parts produced at rates to 9,000 per hour. Optical gaging helps set this level.

The diode plate shown above is an example of the complex, mass-produced, parts turned out to close tolerances by The Metal Stampings Plant, Sylvania Electric Products, Inc., at York, Pennsylvania. Tolerances run to ± .001"; as many as 10 dimensions must be held, including inner and outer diameters. Yet even on parts more difficult than this—parts with tolerances of .0005" and forming rates of 9,000 per hour—Sylvania gets an acceptance rate of over 98%.

Inspection on Kodak Contour Projectors helps Sylvania do the job to the satisfaction of its customers, both internal and external. Operators check the first parts produced by every machine to assure correct setup. Then, throughout the run, production samples are checked at regular intervals—making certain each machine is holding to tolerance. The speed with which these parts can be checked using optical gaging methods has helped slash rejection rates more than 50% since Kodak Contour Projectors were installed.

If you have difficult inspection problems involving quantity, speed, close tolerances or hard-to-measure dimensions like shoulders, holes, radii or angles, there's every reason to expect a solution by optical gaging on a Kodak Contour Projector. There's a representative in your area who can tell you more. To get in touch with him, or for a copy of the booklet, "Projection Gaging with Kodak Contour Projectors," write Special Products Sales Division.

Little training is required to operate a Kodak Contour Projector. Operators sit comfortably in a fully lighted room. The work gets out in a hurry.

EASTMAN KODAK COMPANY, Rochester 4, N. Y.

the KODAK CONTOUR PROJECTOR

Kodak

MILFORD RIVETERS—

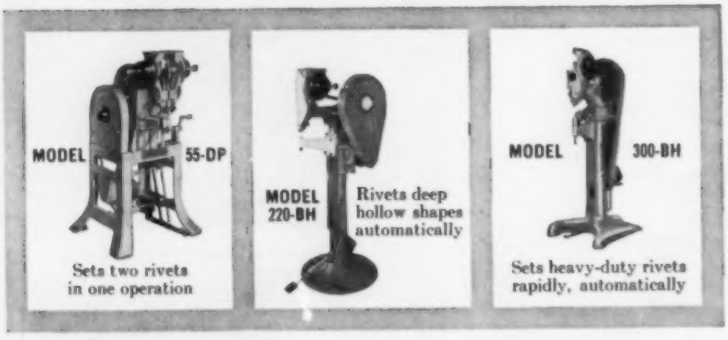
for faster assembly, for dependable fastening

Fasten a wide range of assemblies Safely—Rapidly—Automatically with Milford Rivets and Riveters

Delicate wrist watch bracelets . . . rugged, heavy-duty truck brake lining—a wide range of parts like these are being fastened safely and economically with Milford Rivets and Rivet-Setting Machines.

Call on Milford's versatility and skill to adapt a basic rivet-setting machine to your particular requirements—call on Milford to solve your fastening problems and come up with substantial savings.

To cut production costs, improve product appearance, fasten assemblies automatically—get in touch with Milford!



THE MILFORD RIVET

MILFORD RIVET & MACHINE CO.

MILFORD, CONNECTICUT • HATBORO, PENNSYLVANIA
ELYRIA, OHIO • AURORA, ILLINOIS • NORWALK, CALIF.

scale indicators are needed. Available with one or two pointers, and with or without loading regulator. Minneapolis-Honeywell Regulator Co., Wayne and Windrim Ave., Philadelphia 44, Pa.

For more information—
Circle 91, inside back cover

Solder Resist For Printed Circuits

A solder resist is said to permit selective soldering, minimize bridging over close tolerances and to reduce solder waste. It has a cure temperature of 200 F and requires a cure time of 20 to 30 min. The hard, tough film it deposits is resistant to peeling, pitting or blistering and will not break down at high solder pot temperatures up to 650 F, with immersion of 10 to 15 sec.

This material can be applied by silk screening onto certain areas of the circuit to mask out solder "take", while other areas are left uncoated to permit soldering. London Chemical Company, Inc., Dept. PEN, 1535 N. 31 Ave., Melrose Park, Ill.

For more information—
Circle 92, inside back cover

Relief and Back Pressure Valves

Relief and back pressure valves which can be used with corrosive fluid at pressures to 1500 psi and temperatures to 250 F have Kel-F diaphragms. Available in standard ¼, ½, ¾ and 1 in. sizes. These valves offer a range of pressure settings which are made with a screw driver. Valve bodies are of cast steel, 316 stainless steel, Carpenter No. 20 or Hastelloy C. Milton Roy Co., 1300 E. Mermaid Lane, Philadelphia 18, Pa.

For more information—
Circle 93, inside back cover

Wide-Range Gas Flow-Regulator

With a normal inlet pressure of 6000 psi, this regulator is reported to maintain accuracy with regulated pressure from 0 to 5000 psi. The unit has a burst maximum of 15,000 psi.

(Continued on page 292)

here's proof

This ogive was deep drawn from a sheet of Weirzin.
Photomicrographed cross sections from ogive are magnified 1500 times.

WEIRZIN Electrolytic Zinc-Coated Steel keeps a flawless protective coating even after deepest draws

The edge view cross sections shown above prove that approximately the same thickness of ductile zinc coating remains at the extremity of the draw, 4, as at the base, 1.

That's proof that even during a deep draw Weirzin's tightly bonded coating adheres evenly to its ductile steel base without peeling or flaking, and so continues to provide complete protection against rust or corrosion.

Weirzin is available with or without chemical treatment in coils or cut lengths, in all regular widths and gauges. If you would like specific information on the many ways in which Weirzin may benefit your product, please fill in and mail this coupon today.

WEIRTON STEEL COMPANY
WEIRTON, WEST VIRGINIA
a division of
NATIONAL STEEL CORPORATION

WEIRTON STEEL CO., Weirton, West Virginia

I would like to know more about Weirzin.

My product is_____

NAME_____

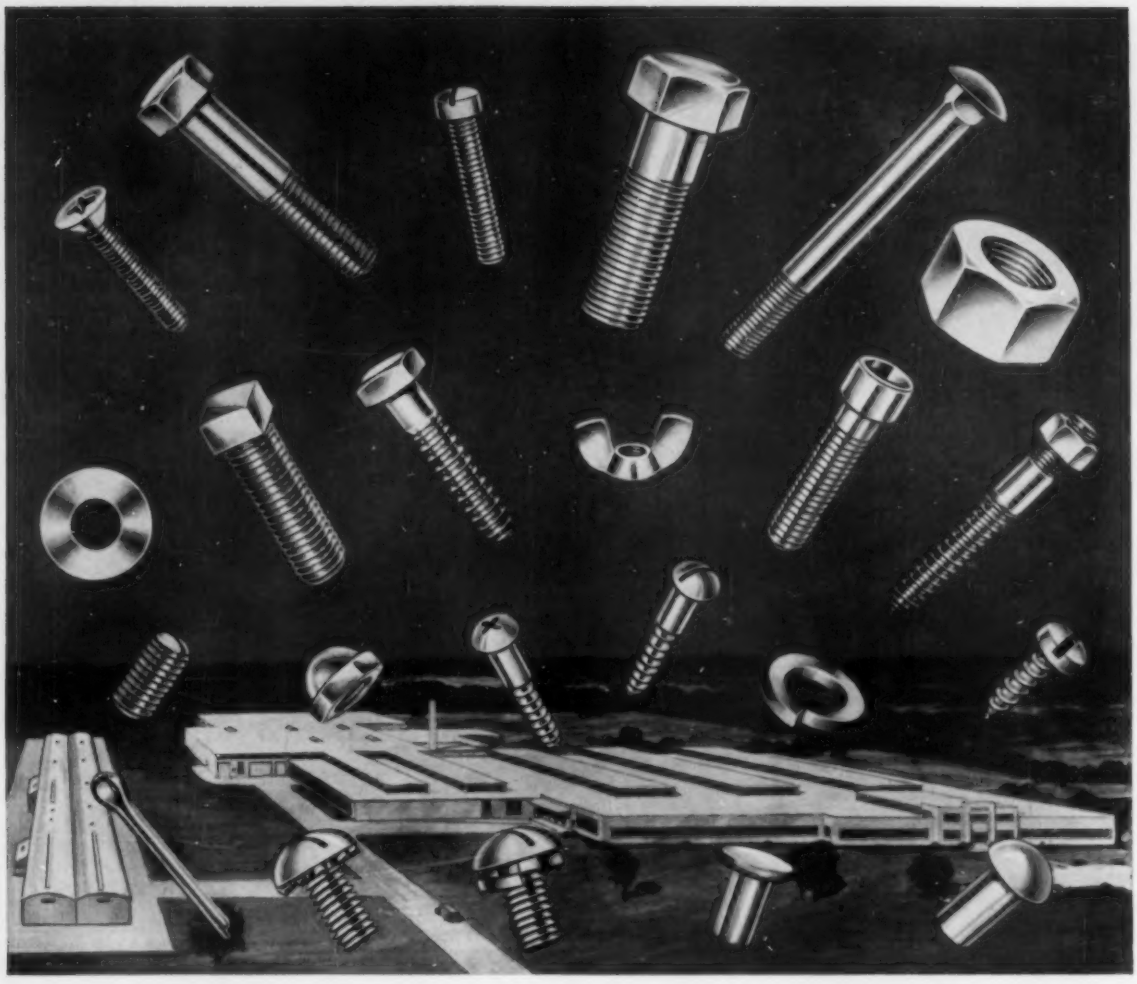
POSITION_____

COMPANY_____

ADDRESS_____

CITY_____ ZONE_____

STATE_____



HARPER...a better source for STAINLESS
and at no added cost

Here are the reasons why stainless bolts, nuts, screws, washers and rivets by Harper will mean longer life, improved appearance to the equipment you make.

- Stronger in tensile
- Higher in yield strength
- Higher in nickel content
- More corrosion resistant
- Engineered to highest standards

You get all these Harper advantages at no added cost. Whether your order is large or small, it will be filled immediately from stock or promptly from the mill.

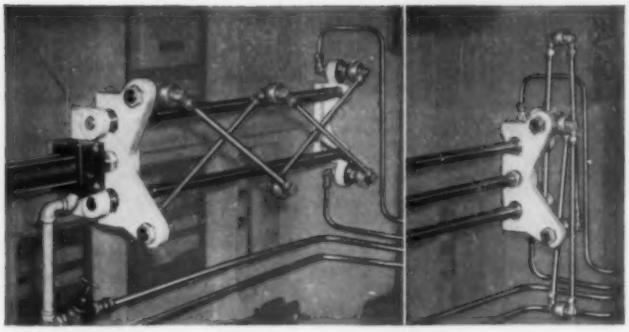
Your Harper distributor has a wide range of highest quality stainless steel fastenings in stock. Call him today or write us for Catalog 26.

Branch Offices in Principal Cities
THE H. M. HARPER COMPANY
8203 Lehigh Avenue, Morton Grove, Ill.

Specialists in all corrosion-resistant fastenings
Bolts • Nuts • Screws • Rivets • Washers
of Brass • Bronze • Monel • Aluminum • Stainless

OVER 7000 ITEMS IN STOCK...HARPER DISTRIBUTORS EVERYWHERE

HARPER
Everlasting Fastenings



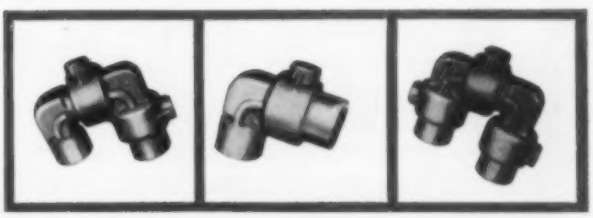
Chiksan Swivel joints, with full 360° rotation allow duplicate sets of lines (left) to be compacted into small spaces (right).

PROBLEM: EXTREME BEND RADII

SOLUTION: **CHIKSAN SWIVEL JOINTS**

Got a bend radii problem? Then let Chiksan engineers go to work on the answer. Chiksan has the years of experience and know-how to handle your problem quickly, efficiently.

Chiksan Swivel Joints provide unlimited flexibility in a compact package to meet your exacting pressure and temperature requirements. Be it for air, hydraulics, fuel, oil, water or other fluids, it will pay you to have Chiksan provide the right swivel joint for *your* bend radii problem.



Typical Chiksan Swivel Joints

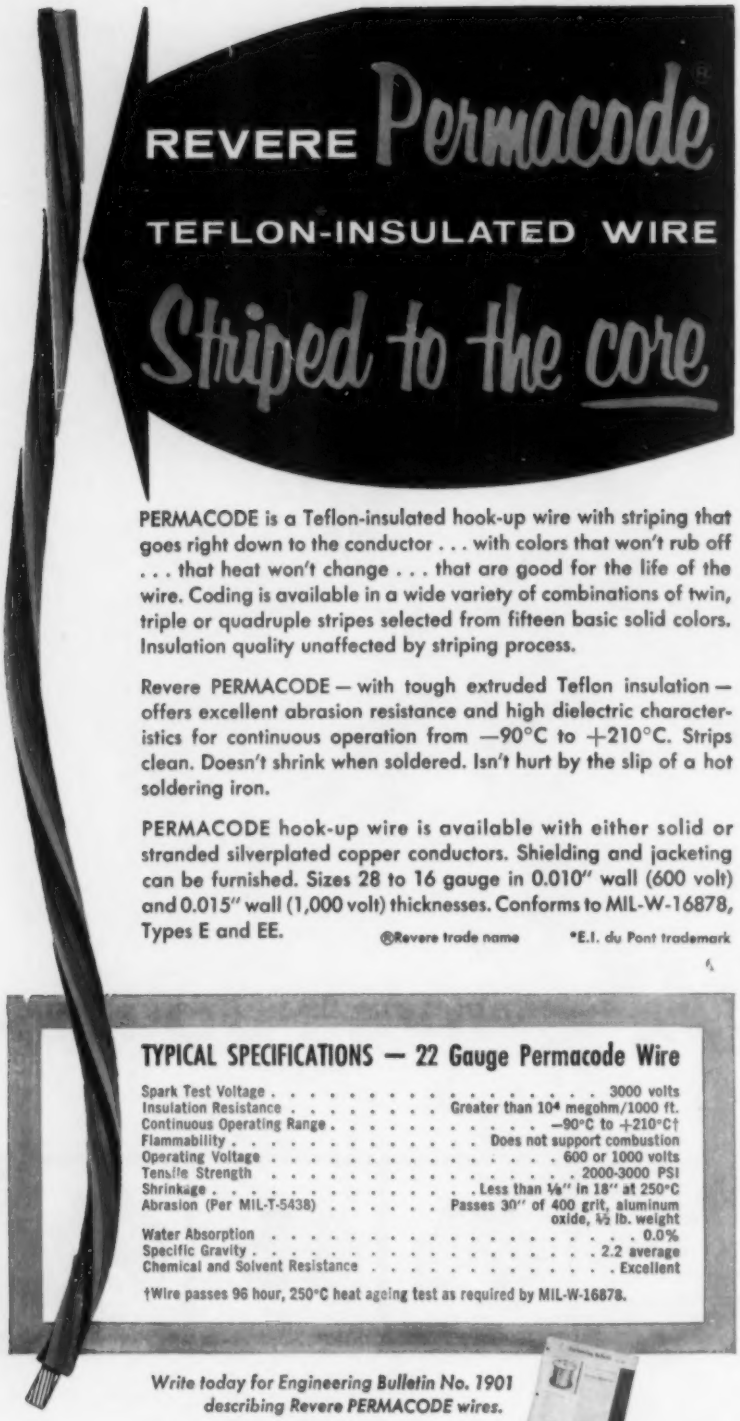
FOR FREE CATALOG WRITE DEPT. 17-12.

CHIKSAN

A SUBSIDIARY OF FOOD MACHINERY AND CHEMICAL CORPORATION

CHIKSAN COMPANY — BREA, CALIFORNIA • CHICAGO 3, ILLINOIS • NEWARK 2, NEW JERSEY

Well Equipment Mfg. Corp. (Division), Houston 1, Texas • Chiksan of Canada, Ltd., Edmonton, Alta



PERMACODE is a Teflon-insulated hook-up wire with striping that goes right down to the conductor . . . with colors that won't rub off . . . that heat won't change . . . that are good for the life of the wire. Coding is available in a wide variety of combinations of twin, triple or quadruple stripes selected from fifteen basic solid colors. Insulation quality unaffected by striping process.

Revere PERMACODE — with tough extruded Teflon insulation — offers excellent abrasion resistance and high dielectric characteristics for continuous operation from —90°C to +210°C. Strips clean. Doesn't shrink when soldered. Isn't hurt by the slip of a hot soldering iron.

PERMACODE hook-up wire is available with either solid or stranded silverplated copper conductors. Shielding and jacketing can be furnished. Sizes 28 to 16 gauge in 0.010" wall (600 volt) and 0.015" wall (1,000 volt) thicknesses. Conforms to MIL-W-16878, Types E and EE.

®Revere trade name *E.I. du Pont trademark

TYPICAL SPECIFICATIONS — 22 Gauge Permacode Wire

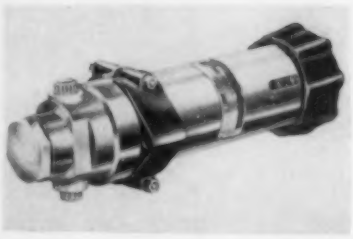
Spark Test Voltage	3000 volts
Insulation Resistance	Greater than 10^4 megohm/1000 ft.
Continuous Operating Range	—90°C to +210°C†
Flammability	Does not support combustion
Operating Voltage	600 or 1000 volts
Tensile Strength	2000-3000 PSI
Shrinkage	Less than 1/8" in 18" at 250°C
Abrasion (Per MIL-T-5438)	Passes 30" of 400 grit, aluminum oxide, 1/2 lb. weight
Water Absorption	0.0%
Specific Gravity	2.2 average
Chemical and Solvent Resistance	Excellent

†Wire passes 96 hour, 250°C heat ageing test as required by MIL-W-16878.

Write today for Engineering Bulletin No. 1901 describing Revere PERMACODE wires.

Revere CORPORATION OF AMERICA 17

WALLINGFORD, CONNECTICUT A Subsidiary of Neptune Meter Company



Maximum required handle torque is 30 in.-lb, due to planetary gear system in handle. It is adaptable for use with air, nitrogen, helium, and gaseous oxygen. Accessory Products Corp., Dept. PN, 616 W. Whittier Blvd., Whittier, Calif.

For more information—
Circle 94, inside back cover

Miniature Voltmeters

These a-c voltmeters have expanded scales. With a specially designed D'Arsonval movement, they are said to have an accuracy of ±5 percent of the expanded portion of the scale, ±1.5 v on a 90-120 v a-c scale. Standard ranges are 90-120, 90-130 and 90-140 v a-c. International Instruments Inc., P.O. Box 2945, New Haven 15, Conn.

For more information—
Circle 95, inside back cover

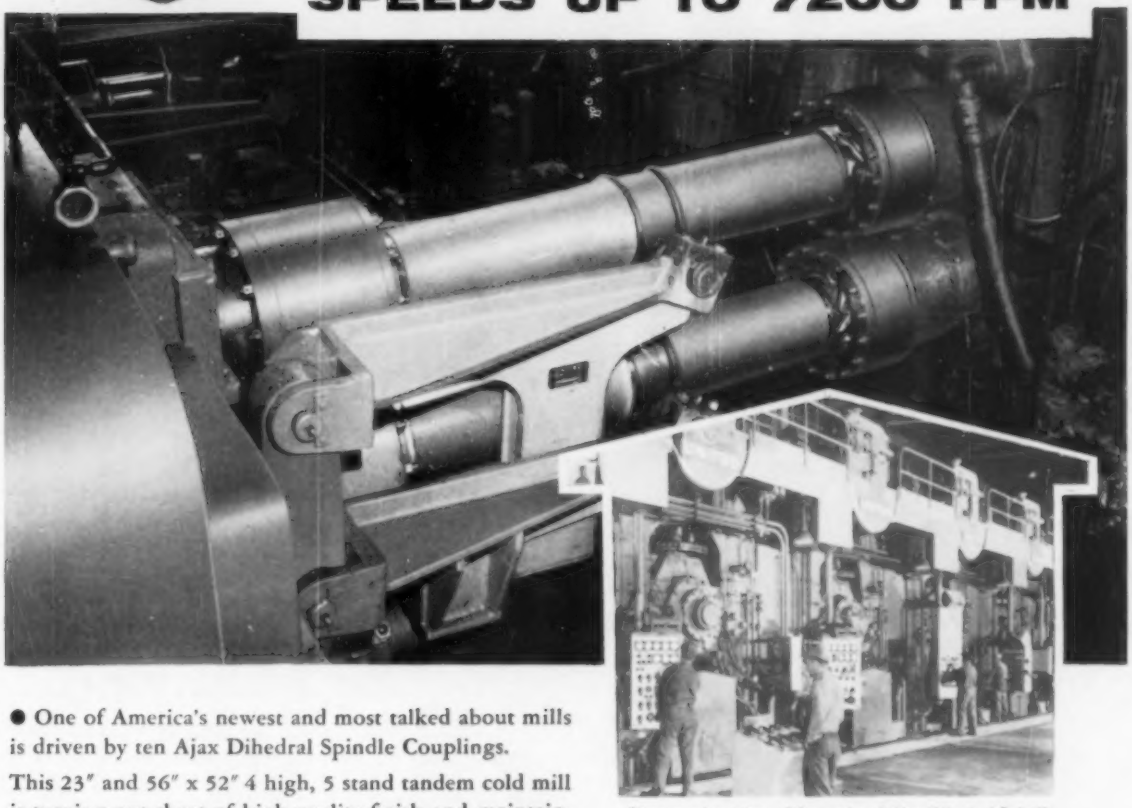
Cyclic and Continuous Lubrication

Two independent lubrication systems, providing both cyclic and continuous oil flow to different bearings on the same machine, are built into a single automatic lubricator. The lubricator is designed specifically for machines with a dual lubrication problem, where some bearings need periodic lubrication, others require oil continuously.

The lubricator consists of two independent gear pumps with a common

(Continued on page 296)

DIHEDRAL SPINDLE DRIVE COUPLINGS HANDLE SPEEDS UP TO 7200 FPM



Close-up shows two of five pairs of Ajax Dihedral Spindle Couplings driving 23" and 56" x 52" 4 high 5 stand tandem cold mill built by United Engineering & Foundry Co. in operation at Weirton Steel Co., a Division of National Steel Corporation.

● One of America's newest and most talked about mills is driven by ten Ajax Dihedral Spindle Couplings.

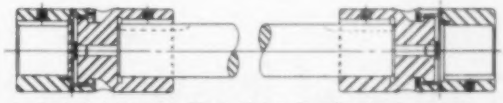
This 23" and 56" x 52" 4 high, 5 stand tandem cold mill is turning out sheet of high quality finish and maintaining close gauge tolerance at speeds up to 7200 fpm.

Uniform angular velocity made possible by Ajax Dihedral Spindle Couplings is an important factor in the performance of this high speed mill built by United Engineering & Foundry Co. for Weirton Steel Co., a Division of National Steel Corporation.

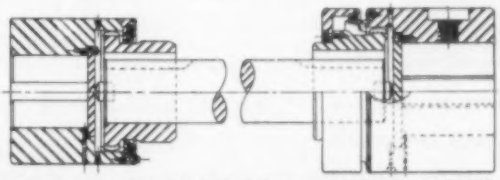
Each of these couplings delivers 2500 hp between drive stand and rolls.

The proven performance of Ajax Dihedral Spindle Couplings is writing new standards into the specifications of mill builders and new figures into the production and maintenance cost records of mill users.

The long experience of Ajax engineers is available to help you in all phases of design, application and operation. Call in the Ajax representative or write us direct.



Another typical style of Ajax Dihedral Spindle Shaft Couplings in several sizes for roll mill drives. Sketch shows 9" diameter by 5'6" overall length Ajax Dihedral Spindle Shaft Coupling. Arranged for booted lubricant retainer seal.



Showing Ajax Dihedral Spindle Shaft Coupling 6'4½" overall with 15¾" diameter coupling on roll end and 13¾" diameter coupling on drive end. Rated torque capacity of this Coupling is approximately 110,000 ft. lbs.

AJAX FLEXIBLE COUPLING CO. INC.

WESTFIELD, N. Y.

Lees-Bradner

hobbing...

Lees-Bradner Gear Hobbers produce the precision gears that go into much of America's automobiles, tractors and industrial equipment. Seven different sizes and types of Federal Ball Bearings are used in these intricate tools, smoothing the way for trouble-free operation.

Toro Manufacturing

or hobbying...

This 10-inch tilting-arbor Toro Power Saw is the answer to a do-it-yourselfer's dream. It will rip through a 2 x 4 like butter, or cut a delicately contoured molding. Federal Ball Bearings on the arbor keep the 10-inch blade humming sweetly.

so much of industry *turns* on FEDERAL ball bearings

It's no longer a question of *where* Federal Ball Bearings are used, but rather where *aren't* they used? Wherever you look – in home, office or industry, Federal Ball Bearings are doing their anti-friction job with quiet dependability. 12,000 sizes. Hundreds of types. Produced by a 50-year-old manufacturer of ball bearings exclusively.

When Federal Ball Bearings are part of so many things you *use*, shouldn't they be part of the things you *make*?

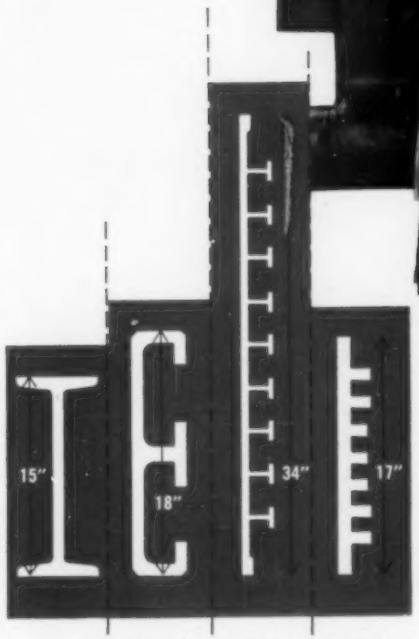
THE FEDERAL BEARINGS CO., INC. • POUGHKEEPSIE, N. Y.

New! Ball bearing and engineering data! *175 pages full in* FEDERAL'S CATALOG! *To get your copy, just write us.*

Federal Ball Bearings

One of America's Largest Ball Bearing Manufacturers

heavy press extrusions



Heavy Press Extrusions now in Production

New 8000 ton press now permits greatest design flexibility. Wide, integrally stiffened skin panels . . . solid, hollow, and stepped extrusions . . . extra large complex shapes . . . can now be obtained from Harvey in all aluminum alloys and in heat-treated lengths up to 80 feet.

New 8000 Ton Extrusion Press at Harvey Aluminum

This giant press, installed at Harvey's Torrance, California facility under the USAF Heavy Press Program, is now producing unusually large and complex aluminum alloy extrusions. These big one-piece structural shapes reduce weight and fabrication costs, make conventional methods of joining smaller components obsolete. And Harvey's completely integrated plant includes the newest supporting and finishing equipment. For the most advanced heavy press extrusions . . . *plus* Harvey's traditional high quality and service . . . contact your Harvey Field Engineer.

Harvey is a leading independent producer of quality aluminum products in all alloys and sizes: Rod and bar, pipe, tube, hollow sections, press forgings, forging stock, impact extrusions, structurals, special shapes, extrusions, screw machine products and other aluminum products. Harvey is also producing similar items in titanium and steel.

Making the most of aluminum

. . . for everyone

HARVEY Aluminum

Harvey Aluminum Sales, Inc.
Torrance, California
Branch Offices in Principal Cities

Note:
Specify properties when you use TEFLON®

EXPERIENCE shows that in converting Teflon powders into shapes the combination of method and raw material used have a definite effect on physical and electrical properties.

Since properties *can* vary, it becomes important to *specify* those needed.

End products made from Fluoroflex®-T (Teflon) rods, sheets and tubes will have the specified, required properties . . . will thus perform properly. For, in producing two grades of Teflon, Resistoflex uses extrusion and molding processes that develop the optimum properties in each . . . with quality carefully controlled for *consistent* performance.

"Electrical grade" Fluoroflex-T rods, sheets and tubing are certified to conform with AMS 3651 on all important electrical and physical properties. They're recommended for the most critical uses.

"Mechanical grade" extruded rods and tubing, having improved resistance to elongation, prove ideal for bearings, valve seats, nozzles and other mechanical parts.

All Fluoroflex-T products are stress relieved for dimensional stability in machined parts. Send for data.

® *Teflon: DuPont trademark* ® *Fluoroflex: Resistoflex trademark*

RESISTOFLEX
CORPORATION

Roseland, N. J. • Western Plant: Burbank, Calif.

WAREHOUSING DISTRIBUTORS: Chicago, Ill. – Colonial Kolonite Co.; Flow Products, Inc. • **Detroit, Mich.** – F. B. Wright Co. • **Hartford, Conn.** – Industrial Safety Supply Co. • **Houston, Tex.** – Lone Star Rubber Co. • **Los Angeles, Calif.** – Western Fibrous Glass Products • **New York, N. Y.** – Allied Plastics • Supply Corp. • **Norwood, Mass.** – Laminated Sheet Products Corp. • **Pittsburgh, Pa.** – Shields Rubber Corp.

drive gear, mounted in a single housing, both drawing oil from a common reservoir in the bottom of the housing. Each pump has its own inlet (from reservoir) and outlet (to distribution line), feeding oil through separate distribution systems to the bearings each serves.

Cyclic pressures can be as high as 150 psi, as low as 25 psi, depending on requirements of the machine being lubricated. Pressure periods, or cycles, range from every 5 min to every ½ hr. Operating pressures may range from 7 to 50 psi, depending on oil volume requirements. Bijur Lubricating Corp., 151 W. Passaic St., Rochelle Park, N. J.

For more information—
Circle 96, inside back cover

Note Pad On A Swing-away Arm

The 6¼ x 10 in. metal clip board is mounted on an arm which permits it to swing away when not in use under a drawing board, desk, table or automobile dash. Pad of paper and mechanical, magnetic pencil included. General Industrial Co., 5742 N. Elston Ave., Chicago, Ill.

For more information—
Circle 97, inside back cover

Measures Three Accelerations at Once

A subminiature high temperature accelerometer that will measure three mutually perpendicular accelerations simultaneously will operate accurately in temperatures from −65 F to 350 F and has an acceleration range to 500 G, frequency response from 25 to

(Continued on page 300)

NEW THREAD CUTTING FASTENER

- LOW COST
- RE-USABLE
- SELF-LOCKING
- VIBRATION-PROOF
- SPRING TAKE-UP

Pulls up tight without backup on flat or contoured surfaces

Specially designed to hold die-cast or cold-forged name plates, emblems and trim against sheet metal surfaces, DOT's new T. C. F. cuts clean, deep threads on unthreaded studs, even those that are chrome plated. Immediately available to fit 1/8" and 3/16" studs.

When used with its pre-assembled plastic sealer, the new T. C. F. makes a watertight seal. The sealer *precedes* the fastener onto the stud so that it is not damaged by the thread-cutting process.

Available *in quantity* with or without sealer from Monadnock Mills subsidiary and Carr Fastener Division.

United-Carr's design staff is ready to apply the same engineering creativity that produced the T. C. F. and thousands of other special-purpose fastening devices to the solution of your special fastening problems. Field representatives are located in most principal cities.

T.C.F. for 1/8" stud shown actual size. Also available for 3/16" stud.

T.C.F. for 1/8" stud with plastic sealer.

MONADNOCK MILLS
SUBSIDIARY
San Leandro, California

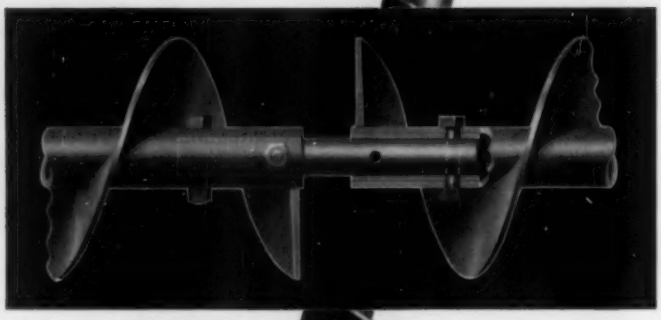
DOT T.C.F.
THREAD-CUTTING FASTENER

CARR FASTENER CO.
DIVISION
Cambridge, Massachusetts

UNITED-CARR FASTENER CORPORATION

JEFFREY SPIRAL CONVEYORS

are built for your particular engineering



No wiggle or wobble to cause extra wear

Jeffrey maintains close tolerances on spiral pitch and diameter; accurately machines the pipe and internal collars to avoid looseness.

YOU CAN design Jeffrey spiral flights and conveyors into your heavy duty, finer products with complete confidence. Spirals are built to close tolerances of pitch and diameter, alloys selected for maximum life. Conveyor pipe and internal collars are accurately machined so there will be no wiggle or wobble to cause early depreciation.

The high quality of Jeffrey spiral conveyors contributes to the dependability which you design into your products.

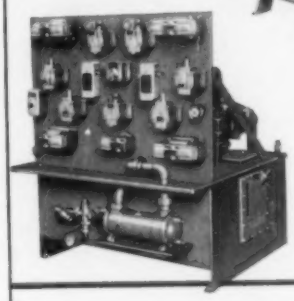
Jeffrey engineers offer data and assistance to designers who are laying out machines which include conveying operations—help in selecting metals and alloys best suited to handling corrosive or abrasive products—types of spirals best suited for transferring and mixing.

For answers to your conveying problems, write The Jeffrey Manufacturing Company, Columbus 16, Ohio.

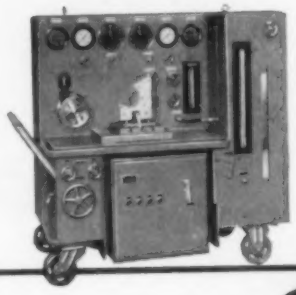
JEFFREY

CONVEYING • PROCESSING • MINING EQUIPMENT...TRANSMISSION MACHINERY...CONTRACT MANUFACTURING

Pulpit type power unit provides full visibility, easy accessibility.

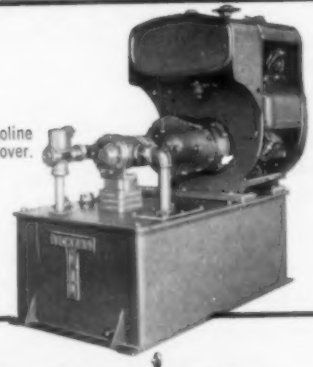


Compact power unit showing gasket-mounted valves.



Portable power unit for testing pumps.

Power unit with gasoline engine as prime mover.



Power unit for hydraulic control of electric furnace.

6837

Individually Designed to Meet *SPECIFIC* Needs

VICKERS®
Custom Built
HYDRAULIC POWER UNITS

DEPENDABLE PERFORMANCE

IMPROVE AND SIMPLIFY DESIGN

REDUCE INSTALLATION COST AND TIME

EASIER SERVICING

BETTER APPEARANCE

Vickers engineers approach the design of a custom-built hydraulic power unit from the standpoint of the customer's INDIVIDUAL needs. The sole objective is to meet HIS requirements with the best hydraulic "package". This assures the most compact, efficient and convenient hydraulic equipment for the particular machine.

A Vickers Hydraulic Power Unit includes all necessary pumps, valves, intermediate piping, oil reservoir, motors, controls, etc., as well as all hydraulic accessories (oil filters, air cleaners, oil level gauges, fittings, etc.). Hydraulic connections can be grouped in a convenient manifold.

In addition to the advantages mentioned above, each Unit is pretested at the factory and ready for immediate operation. Vickers undivided responsibility for the entire hydraulic control system is also an important feature to both the machine builder and his customer. Write for Bulletin 52-45.

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DIVISION OF SPERRY RAND CORPORATION

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***Application Engineering* Offices:** • ATLANTA • CHICAGO CINCINNATI • CLEVELAND • DETROIT • HOUSTON • LOS ANGELES AREA (El Segundo) • MINNEAPOLIS • NEW YORK AREA (Summit, N.J.) • PHILADELPHIA AREA (Media) • PITTSBURGH AREA (Mt. Lebanon) • PORTLAND, ORE. • ROCHESTER ROCKFORD • SAN FRANCISCO AREA (Berkeley) • SEATTLE ST. LOUIS • TULSA • WASHINGTON • WORCESTER

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ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

Ozalid Streamliner 200

full-width whiteprinting for just $995.00!

AT LAST—*economical printmaking in full 42-inch widths!* Here's the brand-new Ozalid Streamliner 200. This compact, low-cost table-model whiteprinter gives you solid production capacity . . . turns out a print in seconds.

It's perfect for the small office—priced low for any budget. And it's an ideal "stand-by" for the big printroom. Use it when other equipment is out of service. Use it for short run "rush" work—without costly interruptions of volume printmaking.

With all of these "plus" features:

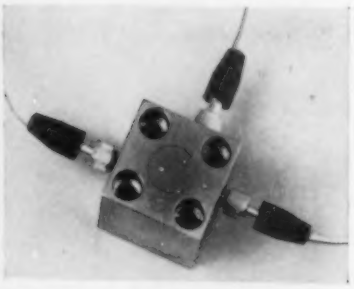
- full 42-inch printmaking capacity
- compact design—only 22" high . . . 27" deep
- simple, easy-to-operate controls
- automatic stacking
- sharp, fully detailed prints

For all the facts on the Streamliner 200, call your local Ozalid representative, or write: Ozalid, Dept. O-12, Johnson City, N. Y.

OZALID®

First name in whiteprinting

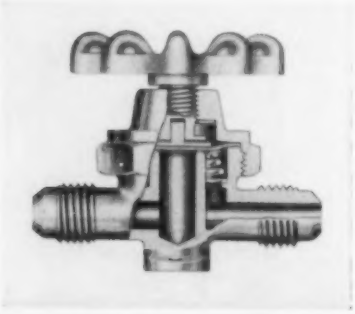
A Division of General Aniline & Film Corporation. In Canada: Hughes Owens Company, Ltd., Montreal



20,000 cps, and sensitivity of 0.8 mv/G.

The unit weighs less than 1 oz and is less than 1 cu in. in volume. Gulton Industries, Metuchen, N. J.

For more information—
Circle 98, inside back cover



Packless Diaphragm Valve

These valves are available in ¼ through ⅜ in. sizes, and can also be furnished with other types of end connections.

Forged brass body with integral mounting flange has inlet and outlet ports in line, non-rotating floating bearing plate, Teflon diaphragm, stainless steel spring. Henry Valve Co., Melrose Park, Ill.

For more information—
Circle 99, inside back cover

Laboratory Power Supply

Supplied on a single chassis, 19¼ x 18 x 14¼ in., suitable for mounting in a standard relay rack. Provisions have been incorporated for remote control operation and for external interlock. The unit is available with either negative or positive output voltages.

Model 922 requires a 105-125 v, 60 cps source, consumes 300 va and delivers from 0 to 30 kv d-c at 0 to 0.5 ma. Regulation is better than 0.1 per-

(Continued on page 304)

NOW—all the advantages of

Permanent Molding—plus Intricate Shell Coring *in*

EATON PERMANENT MOLD GRAY IRON CASTINGS

PERMANENT MOLD GRAY IRON CASTINGS meet critical quality requirements, including intricately cored sections, in a wide range of applications. These castings permit higher machining feeds and speeds, with substantially increased tool life. Characteristics of these castings include dense, non-porous, homogeneous structure, freedom from inclusions, excellent tensile strength, and the ability to take high surface finishes.

These qualities particularly recommend Eaton Permanent Mold Gray Iron Castings for such uses as high pressure control mechanisms, refrigeration and air conditioning parts, power steering and power braking components, household appliance parts, pump bodies, hydraulic cylinders, and countless other critical applications.

If you have applications where more than ordinary quality is required, our engineers will be happy to work with you.

EATON *FOUNDRY DIVISION*
MANUFACTURING COMPANY
VASSAR, MICHIGAN

Flash-Butt Welding

How to Use It to Improve Product Design and Quality

What is Flash-butt Welding?

Flash-butt welding is a resistance welding process for end to end joining of rods, tubes, bars, forgings, fittings, etc., to achieve the greatest possible strength. It is accomplished by positioning the pieces to be joined with clamping electrodes so that there is initially light contact between abutting edges (Fig. 1).

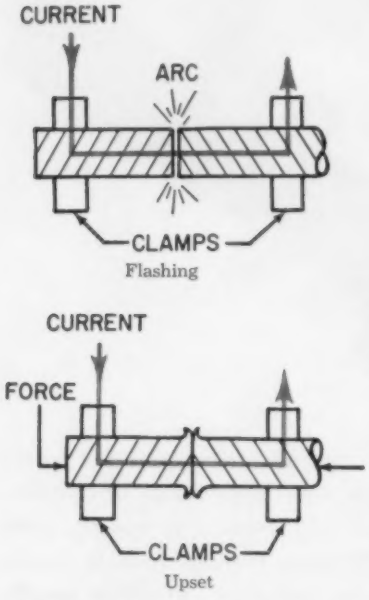


Fig. 1. Flash-butt welding process.

Introduction of the current causes flashing which generates great heat. As the metal is burned away the pieces are moved together in an accelerating motion. Thus, uniform flashing action is maintained for the most efficient heating process. When the inner faces obtain the proper temperature, they are forced together under high pressure and the current is cut off. The impurities (oxides, slag, etc.) formed during flashing are forced out in the upset action leaving pure base metal to form a high strength bond (Fig. 3).

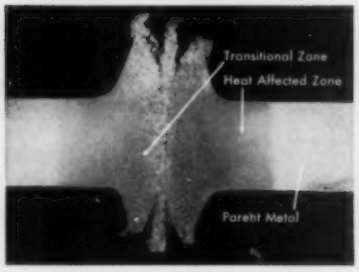


Fig. 2. Macrograph of 2" O.D. x .095" wall of 4140 alloy steel tubing flash-butt welded on a Sciaky Type BMW. 3-400 machine.

Advantages of Flash-butt Welding

Flash-butt welding offers a 100% strength factor compared to 80% strength factor for flame and arc welds. Further, no extra material such as gas, rod, or flux is required. *The material itself forms the weld.*

Flash-butt welding has low power demand and power consumption. Higher production speeds are more readily achieved with this process than with any other fastening method. The localized heat minimizes part distortion. Generally, no special preparation of the weld surfaces is required.

Simplicity and effectiveness of the Sciaky Flash-butt weld technique reduces multi-step fastening operations to just one. One operator (not skilled) can consistently produce high quality welds.

Fig. 3. Destruction test on extruded aluminum miter joint. Note that failure is in parent metal, not in the weld.

Dissimilar metals with widely varying melting temperatures are easily flash-butt welded.

When to Design for Flash-butt Welding

Whenever ideal flash-butt welds are required, the size and shape of the parts to be welded should be identical. However, a maximum of 15% variation in end dimension is usually permissible for commercial usage. New applications for this process are opening up every day. Often little, or no change in existing design allows conversion to high production flash-butt welding.

New Research Center for Your Design Problems

Sciaky's new three-quarter million dollar Research Center is equipped with the most advanced resistance welding machines, testing instruments, and trained personnel. The entire facility is devoted to solving *your* joining problems and advancing the application and development of resistance welding. The Research Center invites *you* to submit your fastening design problems.

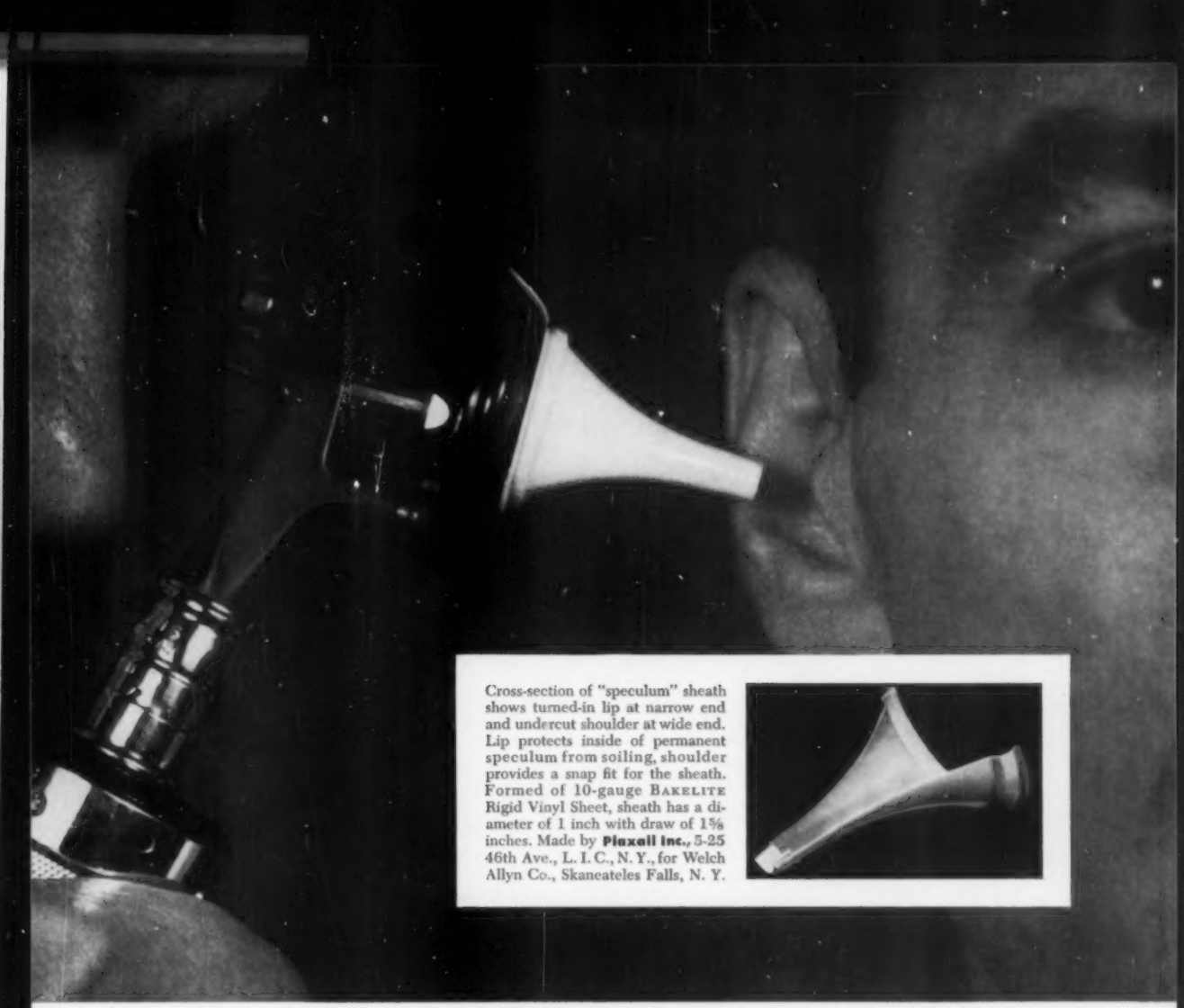
Build Your Data File with Free Sciaky Literature

Write today on your company letterhead describing your particular field of interest. We will send suitable back issues (as well as future issues) of our "Resistance Welding At Work" publication, showing typical design problems solved by this method of fastening. All contain impressive case history examples of Sciaky basic thinking—resistance welding techniques designed to do more *useful work* at *lower operating costs* with *maximum reliability.*

Largest Manufacturers of Resistance Welding Machines in the World

SCIAKY®

Sciaky Bros., Inc., 4913 West 67th Street, Chicago 38, Ill., Portsmouth 7-5600



Cross-section of "speculum" sheath shows turned-in lip at narrow end and undercut shoulder at wide end. Lip protects inside of permanent speculum from soiling, shoulder provides a snap fit for the sheath. Formed of 10-gauge BAKELITE Rigid Vinyl Sheet, sheath has a diameter of 1 inch with draw of 1⅝ inches. Made by **Plaxall Inc.**, 5-25 46th Ave., L. I. C., N. Y., for Welch Allyn Co., Skaneateles Falls, N. Y.

BAKELITE Rigid Vinyl Sheet makes possible this

Intricate, accurate, disposable part

The design idea is a reality because BAKELITE Brand Rigid Vinyl Sheet was the only material that could be vacuum-formed to so deep a draw, according to the manufacturer. It's a sanitary disposable sheath for the "speculum" of an "otoscope" used in ear examinations.

These sheaths cost only a little over a cent apiece because pressure-forming BAKELITE Rigid Vinyl Sheets is such a fast, low-cost process. Notice the deep, complex draw. Precise, too. The sheath works in close quarters. It has to be thin, tight-fitting, and strong enough to be snapped onto the speculum without crinkling or tearing.

One material—BAKELITE Rigid Vinyl Sheet—met all requirements. In addition, its service properties include *dimensional stability* and resistance to water, oil, and chemicals. Clear transparent, as well as colored translucent and opaque sheet stock is available. Learn more about it by writing Dept. VU-145.

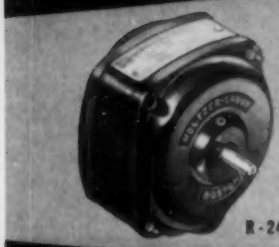
BAKELITE BRAND PLASTICS

BAKELITE COMPANY, *A Division of Union Carbide and Carbon Corporation* UCC 30 East 42nd Street, New York 17, N. Y.

In Canada: Bakelite Company, Division of Union Carbide Canada Limited, Belleville, Ontario

The term BAKELITE and the Trefoil Symbol are registered trade-marks of UCC.

HOLTZER-CABOT



R-24 Motor

Synchronous and Induction Capacitor Type Motors

R-25 Motor

R-24. Typical applications for this reversible, 4-pole induction motor are in servo mechanisms, as a balancing motor in recording instruments or as a control motor for voltage regulators. It has low rotor inertia for fast response applications. When operated 2 phase, it can be controlled electronically; or operated single phase as a permanent split capacitor motor.

R-25. Typical uses are for recording instruments, dictating and adding machines. Approximately 2½" in diameter, it is available in either induction or synchronous construction with reversible rotation.

Both the R-24 and R-25 are available with gear case speeds from 1/2 to 3600 RPM, torque ratings up to 75 oz. inches or higher, and single phase, 2 or 3 phase.

HOLTZER-CABOT ESTABLISHED NP

HOLTZER-CABOT MOTOR DIVISION
NATIONAL PNEUMATIC CO., INC.
125 Amory Street, Boston 19, Mass.

GENTLEMEN: Please send me data sheets on the Holtzer-Cabot R-24 and R-25 Size Motors.

Please have representative call _____ (date)

Name _____

Company _____

Street _____

City _____ Zone ____ State _____

cent and ripple is less than 0.1 percent rms. Telectro Industries Corp., 35-18 37 St., Long Island City 1, N. Y.

For more information—
Circle 100, inside back cover

Flanged Connection For Hydraulic Tubing

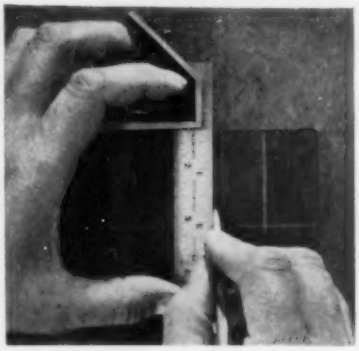
The flanged fitting provides a means of connecting flared tubing to hydraulic equipment, such as pumps, compressors, engines. The fitting is available with a variety of gasket materials. W-S Fittings Div., P.O. Box 95, Roselle, N. J.

For more information—
Circle 101, inside back cover

Adjustable Torque Motor

This motor, which was designed especially for automatic garage door openers, is adaptable for other applications, among which are valve operating equipment and measuring devices. Output torque is easily adjustable from 0 to 1000 in.-lb at 100 rpm. This motor can be made to cut off at pre-determined overload. Brown-Brockmeyer Co., Dayton 1, Ohio.

For more information—
Circle 102, inside back cover



Carbide Scriber for Metals, Glass, Plastics

This tool will scribe or etch metals, including hardened steel, aluminum, corrugated sheet, brass, bronze, Monel, and gems, glass, ceramics, plastics. Solid carbide tip is diamond ground and lapped. This tip is secured within the tool and is mounted in a polished aluminum handle. Greist Mfg. Co., New Haven 15, Conn.

For more information—
Circle 103, inside back cover

NOISE CONTROL

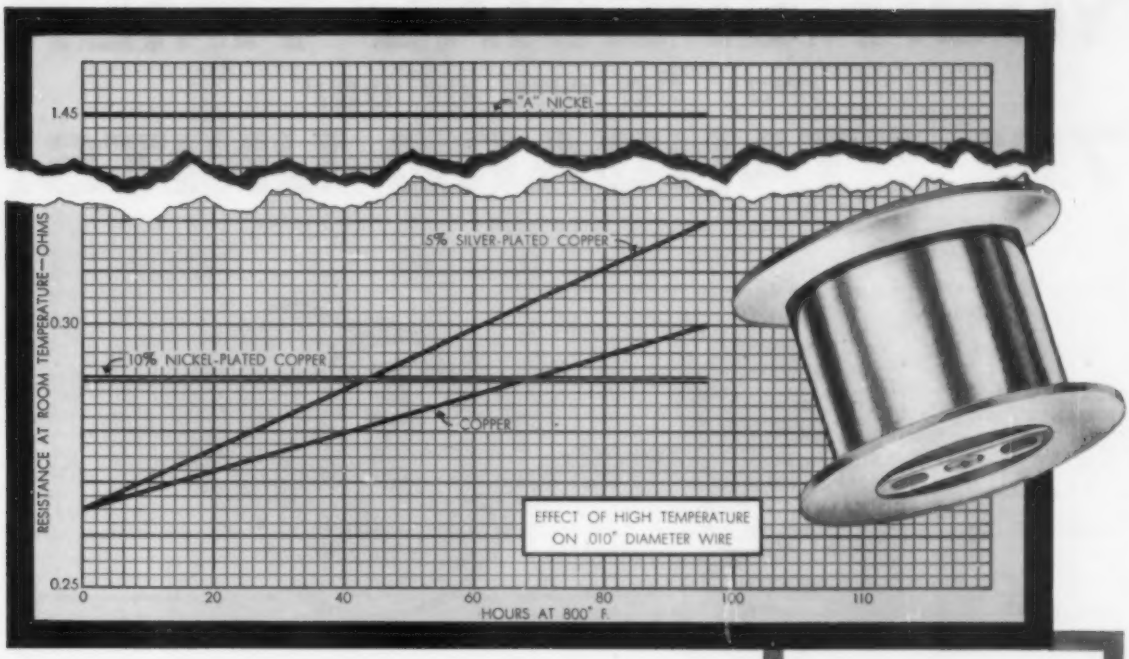
. . . is now as necessary in many industries as heating and ventilating. Large noise-control installations and those presenting especially difficult problems are best handled by experienced acoustical engineering organizations but many annoying conditions can be relieved effectively by following the general procedures outlined in acoustical information already widely available in print.

To supplement such technical information, we present, in the NEW 6-page 3-color bulletin illustrated above, practical working diagrams and directions for applying Diamond Perforated Metal Sheets to the construction of Acoustical Ceilings, Side Walls and Enclosures, together with many illustrations of attractive patterns now available in design strengthened perforated sheets of Steel, Aluminum and other commercial metals.

Do YOU have a noise problem? If so, a copy of Bulletin No. 45 "Diamond Perforated Metal Sheets for Acoustical Treatment" will be forwarded promptly on request. No charge or obligation but kindly state your business connection.

DIAMOND MANUFACTURING CO.
Box 40 WYOMING (Wilkes-Barre Area) PENNA.

West Coast Plant, Diamond Perforated Metals Co.
17915 So. Figueroa St., Gardena, California
Los Angeles Area



Nickel-plated copper...

for high conductivity at elevated temperatures

SYLVANIA's Nickel-plated copper wire combines the conductivity of copper with the corrosion-resistant properties of nickel for applications involving temperatures ranging from 350° Fahrenheit to 700° Fahrenheit.

Equal lengths of Nickel-plated copper and three other wires were heated in air at 800° Fahrenheit for an extended period to determine the effect of heat on conductivity.

Nickel-plated copper, more than any of the other wires except for pure nickel, holds its original low resistance. It's this feature which, in many cases, has made Nickel-plated copper more desirable than costlier wires used where conductivity must remain constant under high temperature environment.

Nickel-plated copper wire can be supplied in a full range of diameters from .250" to .005".

Sylvania is the only major wire supplier with complete facilities for plating and cladding wire. This makes it possible to provide you with an experienced, objective recommendation as to whether a plated or a clad wire is best suited for your application.

In addition, Sylvania's Parts Division offers you complete 4-way service including custom molded plastic parts, small metal parts ranging from wire forms to deep drawn parts, and special electronic components. Write for the "Portfolio of 4-way Service" and the new technical bulletin on Nickel-Plated Copper Wire.

SYLVANIA PARTS DIVISION

Sylvania Electric Products Inc., Parts Division, Warren, Pennsylvania

SPECIAL WIRE · METAL STAMPINGS · MOLDED PLASTIC · ELECTRONIC COMPONENTS

4-way service from one source

YOUR "SPECIAL" TIMER
may be one of our
721 STANDARD UNITS!

We have 20 years of experience in developing new timers to meet our customers' widely varying requirements. Our Engineering Department not only originates new designs, but also develops modifications for that purpose. That's why most requests for special timers can be filled without delay—by one of the 721 combinations we've developed so far from our 17 basic types of timers. But if we don't have what you want on hand, we'll welcome the chance to design and make it for you! And quickly too!

We manufacture a complete line of timers in these 4 broad classifications:

INTERVAL TIMERS • TIME DELAY TIMERS
RE-CYCLING TIMERS • RUNNING TIME METERS

Our large stock assures you of rapid deliveries—even when we have to create a brand new timer for your special needs. Ask us first—you may save yourself much lost motion... and your inquiry will receive prompt attention.

Timers that Control the Pulse Beat of Industry

INDUSTRIAL TIMER CORPORATION

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INSIDE INFO FROM HOLO-KROME

THE SECRET'S IN THE SOCKET!

Holo-Krome's forging method assures untapered sockets . . . lets the hex key bear evenly and firmly against the entire socket wall. The result: easier, faster assembly . . . longer key life . . . fewer damaged screws!

No wall taper in Holo-Krome sockets!

Compare These Other H-K Features!

COMPLETELY FORGED SOCKET HEAD . . . no drilling or broaching—metal fibers stay intact for stronger hex sockets.

SCIENTIFICALLY DESIGNED SOCKETS . . . depth carefully proportioned to give greatest head and socket strength, firmest key grip.

SHARP HEX CORNERS . . . carefully formed socket corners resist internal reaming.

For the finest in Socket Screw products . . . for revolutionary SAME-DAY SERVICE, the name to remember is Holo-Krome!

LOOK INSIDE A HOLO-KROME SOCKET!

Send in the coupon below and we'll send you FREE an H-K Socket Cap Screw (we've omitted heat treating to let you get a better look at the mirror finish and sharp hex corners under the usual black finish). Look it over carefully, and see for yourself what a real difference H-K quality and skill can make!

Please send me FREE a Holo-Krome Socket Screw for my inspection.

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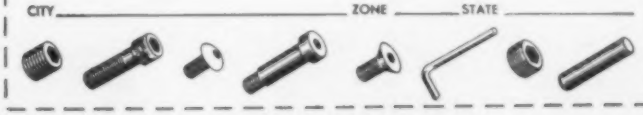


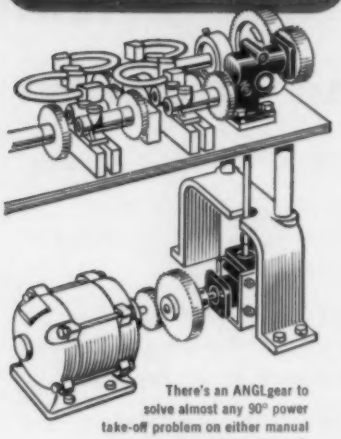
HOLO-KROME

THE HOLO-KROME SCREW CORP., HARTFORD 10, CONN.

Sold only through authorized Holo-Krome distributors.

ANGLgear

simple
compact
positive
90° drive



There's an ANGLgear to solve almost any 90° power take-off problem on either manual or power operated equipment.

In the application illustrated two ANGLgears provide a simple, compact, *positive* 90° drive. Because of its optional mounting features, ANGLgear was easy to design into this application.

ANGLgear combines light weight with high capacity. Model R-320, for instance, weighs only 2.2 lb., yet will transmit a torque of 1500 lb. in.

ANGLgear has no exposed working parts. Its hardened bevel gears and antifriction bearings are completely enclosed, permanently lubricated. This assures virtually maintenance-free service.

Standardized ANGLgear — always less costly than custom-made drives — is available immediately from stock in 3 sizes, with 1-1 or 2-1 gear ratios and 2- or 3-way shafting. See our data in Sweet's Product Design File; then contact your local distributor or write us.

AIRBORNE

AIRBORNE ACCESSORIES® CORPORATION
HILLSIDE 5, NEW JERSEY

CATALOGS and BULLETINS

To obtain copies of literature described below, circle corresponding number on postcard inside back cover. For those catalogs and bulletins available only when requested on company letterhead, see page 328.

Pressure Sensitive Tapes–Folder, 6 pp. Contains data on tape which will retain its adhesion and high tensile strength over a temperature range of nearly 700 F. Mystik Adhesive Products, 2635 N. Kildare, Chicago, Ill.

Circle 104, inside back cover

Fasteners and Vibration Dampeners–Brochure, 4 pp. Contains data and diagrams on tensile strength, sealing and anti-vibration characteristics. Vibrex Fastener Corp., Mt. Kisco, N. Y.

Circle 105, inside back cover

Synthetic Mica–Data File, 24 pp. Contains data and charts on properties, comparisons and uses of ceramoplastics and glass-bonded mica. Mycalex Corp. of America, Clifton Blvd., Clifton, N. J.

Circle 106, inside back cover

Custom Design File–Booklet, 9 pp. Contains information on the variety of custom power supply work done by the NJE engineering staff. NJE Corp., 345 Carnegie Ave., Kenilworth, N. J.

Circle 107, inside back cover

Torque Motors–Bulletin BAW 56, 8 pp. Contains data and diagrams on special motors and collector rings for completing electric circuits between stationary and rotating parts. B. A. Wesche Electric Co., 1623 Vine St., Cincinnati 10, Ohio.

Circle 108, inside back cover

Index of Instrumentation Literature–Bulletin G2, 20 pp. Contains index of catalogs, bulletins, and articles from magazine published by Minneapolis Honeywell Regulator Co., Wayne and Windrim Ave., Philadelphia 44, Pa.

Circle 109, inside back cover

Gear Motors–Bulletin GEA-6133A, 8 pp. Contains data, dimensions and ratings. General Electric Co., Schenectady 5, N. Y.

Circle 110, inside back cover

Vertical Filing System–Catalog 5, 5 pp. Contains data on aluminum binders which will hold 1 to 150 sheets. Plan Hold, 5204 Chakemco St., South Gate, Calif.

Circle 111, inside back cover

Industrial Friction Materials–Booklet FM35A, 16 pp. Contains data and characteristics on asbestos brake blocks, linings and clutch facings. Johns-Manville, 22 E. 40 St., New York 16, N. Y.

Circle 112, inside back cover

Socket Screws–Brochure, 4 pp. Describes head cap screws made of heat treated alloy steel, or 18-8 stainless steel, in microsizes from No. 0 to 3. Cleveland Cap Screw Co., Box 545, 2917 E. 79 St., Cleveland 4, Ohio.

Circle 113, inside back cover

Capacitors–Bulletin GEC808C, 5 pp. Contains data on units designed for low voltage a-c and d-c applications. General Electric Co., Schenectady 5, N. Y.

Circle 114, inside back cover

Spherical Corners–Brochure, 1 pp. Contains data and chart on 96 sizes, radii range form ¼ to 3″ and thicknesses from 18 to 10 gage. Conner Steel Products, 24690 Telegraph Road, Detroit 19, Mich.

Circle 115, inside back cover

Hydraulic-Pneumatic Components–Bulletin 156, 52 pp. Contains diagrams and data on valves, brake equipment and special components. Aircraft Products Co., Bridgeport, Pa.

Circle 116, inside back cover

Wire Screen–Brochure, 2 pp. Contains pictures and charts on assorted weaves. Cleveland Wire Cloth and Mfg. Co., 3578 E. 78 St., Cleveland 5, Ohio

Circle 117, inside back cover

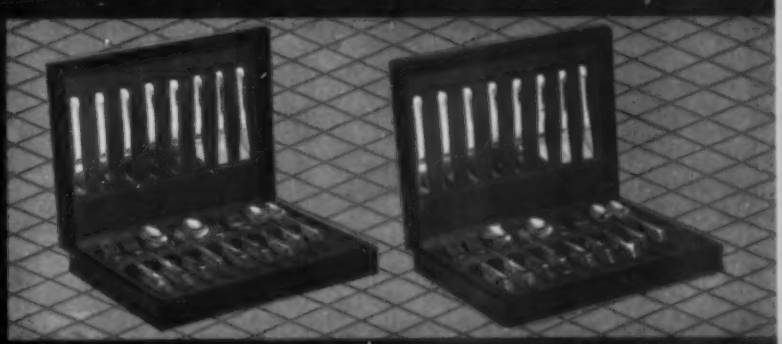
Control Devices for JIC Standards–Bulletin GEA 6317, 12 pp. Contains

(Continued on page 312)

A NEW high finish and inherent beauty that comes through in the finished product makes certain grades of Sharon Stainless Steels practically indistinguishable from fine silver.

Think for a moment how this extra quality will enhance the appearance, utility and saleability of your product.

Which one is the *Stainless Steel?*



Stainless Steel Tableware never dulls, or tarnishes, self-polishes with use

SHARON *Stainless Steel*

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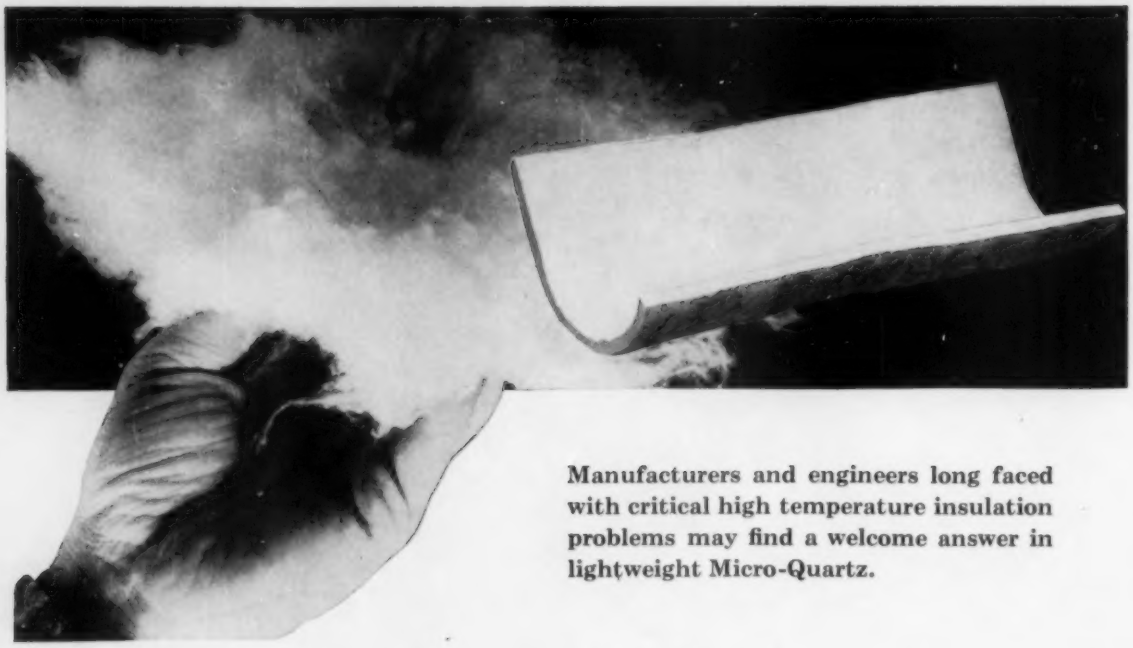
L·O·F Glass Fibers Company Introduces

MICRO-QUARTZ—The new insulation for the 2000°-2500° Temperature Range!



Manufacturers and engineers long faced with critical high temperature insulation problems may find a welcome answer in lightweight Micro-Quartz.

L·O·F Glass Fibers Company announces Micro-Quartz—a remarkable, new insulation for temperatures ranging, under many conditions, up to 2500°!

Micro-Quartz is available in felted form and in bulk. It is light in weight and composed of 98% pure quartz. It is resilient, exceptionally efficient, and resistant to vibration and air flow. Because it has no organic binder, its performance, stability, and thermal conductivity are those of the quartz fibers themselves.

The range of uses to which Micro-Quartz can be put is very broad, with possible applications in all industries doing work in the high-temperature field. It may be the answer to high temperature problems involving low heat capacity and high thermal diffusivity, frequent- or rapid-heating cycles, and problems of weight, space limitations, and vibration.

Micro-Quartz fibers are available in paper form. Can be impregnated or coated for electrical applications.

Requests on your business letterhead for more information, and a Micro-Quartz sample, will receive prompt attention. Write: L·O·F Glass Fibers Company, Dept. 4-126, 1810 Madison Ave., Toledo 1, Ohio.

PRODUCT DATA ON STANDARD MICRO-QUARTZ SHEETS*

Average Fiber Diameter—0.75 microns or 0.00003 inches

Density—Standard nominal density is 3 lbs./cu. ft.

Weight—0.047 lbs. per sq. ft.—0.005 lbs.

Thickness of sheet—Standard nominal th ckness is 3/16 inches

Width of sheet—34 inches

Length of sheet—71 inches

*Other thicknesses and densities are available. Sheets can be fabricated to fit your application.

LOF GLASS FIBERS Micro-Quartz HIGH TEMPERATURE INSULATION

L·O·F GLASS FIBERS COMPANY

TOLEDO 1, OHIO

Makers of glass fibers by the exclusive "Electronic-Extrusion" process

The best stainless tubing for a specific application cannot be identified by surface appearance alone. The answer is found in the grain structure. Because your guarantee of satisfactory service rests *inside* the metal, it is most important for the stainless tubing buyer to consider his supplier's methods of manufacture.

Corrosion resistance, which prevents product contamination, depends upon heat treatment. Heat treatment of stainless steel tubing for a specific end use may vary according to grade, size of tube and service requirements involved. For instance, the austenitic grades of stainless steel have optimum corrosion resistance only when all carbides have been dissolved and retained in solution by rapid cooling. At B&W, heat treatment is rigidly controlled, and every piece of stainless tubing is heat treated to provide optimum corrosion resistance when that property is required.

For virtually any application—pressure or mechanical—B&W can provide either seamless or welded stainless tubing in any number of grades, in a broad size range. Help is available through B&W Regional Sales Offices and a nationwide network of experienced tubing distributors. Mr. Tubes—your link to B&W—will be pleased to furnish detailed answers to your stainless tubing problems. The Babcock & Wilcox Company, Tubular Products Division, Beaver Falls, Pa.

TA-6056-P

Seamless and welded tubular products, seamless welding fittings and forged steel flanges—in carbon, alloy and stainless steels

smaller . . . lighter assemblies

KELOX tapped and threaded inserts provide new opportunities for reducing the size and weight of assemblies. Patented "key-locking" produces no stress concentrations and allows complete use of external threads for maximum holding power. KELOX design affords minimum depth of insert. The ability of KELOX inserts to withstand high torques has been verified without reservation by an independent laboratory.

Available for all external thread sizes from 0 to 3 inches, low-cost KELOX inserts are easy to install and remove . . . made of many materials (alloy steel, corrosion-resistant steel, aluminum alloy, brass, monel, etc.) . . . come with thick or thin walls for use with most materials—aluminum, magnesium, plastic, "pot" metal, titanium, steel, etc.

EXTRA LARGE

The ever-increasing use of extra-large KELOX inserts (up to any specified diameter) is a result of their unmatched performance—a performance that verifies the "key-locking" principle. KELOX inserts will not rotate or loosen with vibration . . . make optimum use of tapped hole . . . provide maximum holding power . . . save weight and space.

EXTRA SMALL

Sub-miniature inserts in 0, 1, 2, 3, and 4 thread sizes, *made only by KELOX*, will make miniature assemblies even smaller and lighter. Identical to regular non-rotating KELOX inserts . . . do not break down protective coatings like ceramic . . . require no special threads . . . give maximum reduction of space and weight for improved product design.

KELOX® trademark

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P.O. Box 169
Toronto 18, Canada

F. D. Barringer Company
542 Spring Street, N. W.
Atlanta 3, Georgia

Monogram Manufacturing Co.
8557 Higuera Street
Culver City, California

data on machine tool relay, oil-tight pushbutton, solenoid, limit switch, magnetic starter, plugging switch, and pneumatic time-delay relay. General Electric Co., Schenectady 5, N. Y.

Circle 118, inside back cover

Static Switching Systems—Bulletin GEA 6364, 8 pp. Describes the operation and lists advantages and flexibility. General Electric Co., Schenectady 5, N. Y.

Circle 119, inside back cover

Fluid Teflon for Thread-Sealing and Anti-Seize—Bulletin, 6 pp. Describes fluids used for metal, plastic, carbon and ceramic systems and equipment. Eco Engineering Co., 12 New York Ave., Newark 5, N. J.

Circle 120, inside back cover

Coated Yarns—Folder, 5 pp. Describes application, properties and data on vinyl, Teflon, and silicone-coated glass yarns. Chemo Textiles, Inc., West Warwick, R. I.

Circle 121, inside back cover

Metallurgists' Problems—Chart shows problem and cross-indexes solutions. Drop Forging Assn., 419 S. Walnut St., Lansing 33, Mich.

Circle 122, inside back cover

Single and Multi-turn Potentiometers—Data sheet 54-34, 2 pp. Contains specifications on ten units. Helipot Corp., Newport Beach, Calif.

Circle 123, inside back cover

Non-linear Potentiometers—Data sheet 54-74, 4 pp. Contains chart and specifications on 75 models. Helipot Corp., Newport Beach, Calif.

Circle 124, inside back cover

Control Valves—Bulletin LB2, 12 pp. Contains data on construction and operating characteristics of valves, sizes 1 through 4 in. Conoflow Corp., 2100 Arch St., Philadelphia 3, Pa.

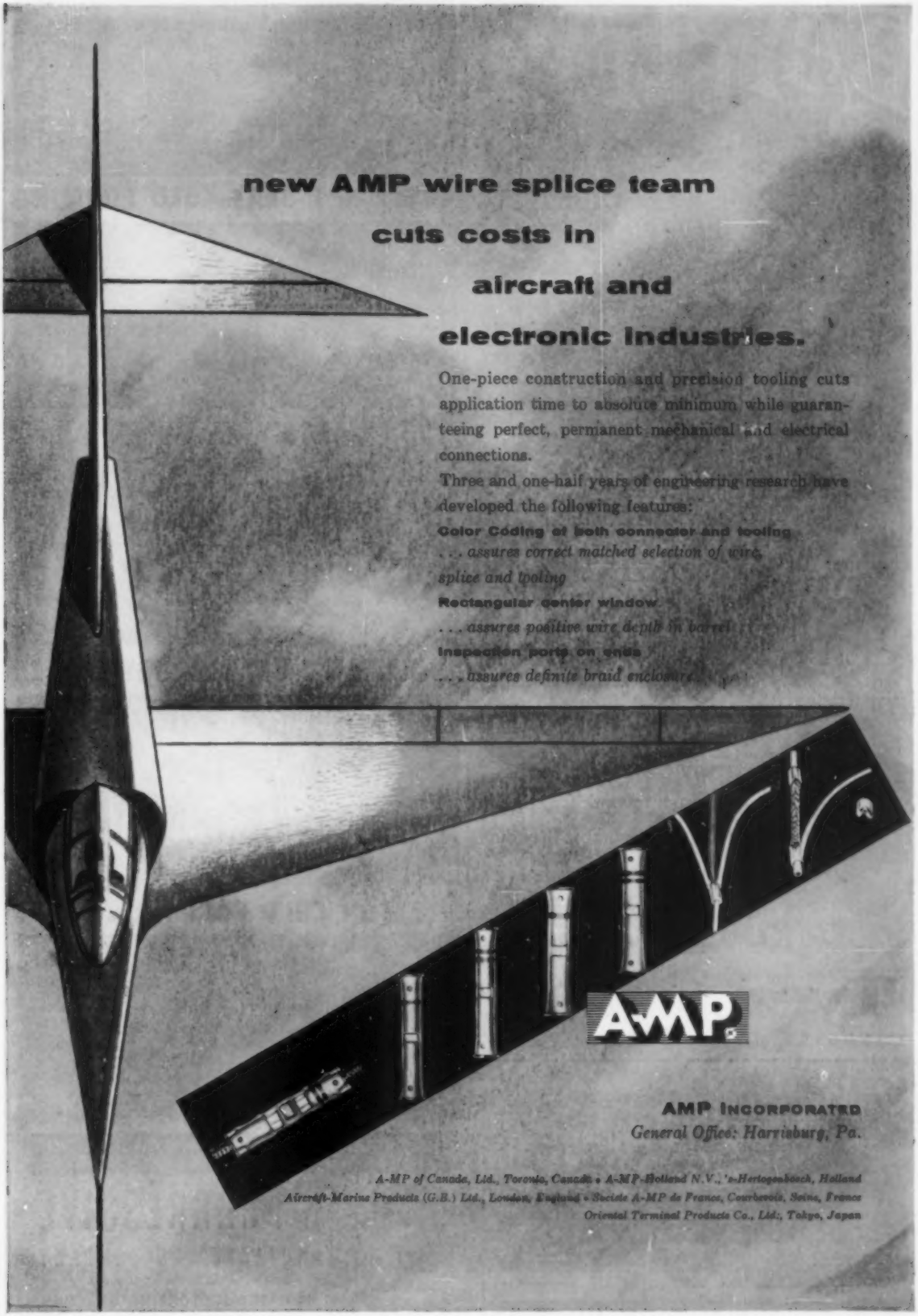
Circle 125, inside back cover

Vibration Pickups and Meters—Bulletin 124 E, 6 pp. Contains data, diagrams and chart. MB Mfg. Co., 1060 State St., New Haven 11, Conn.

Circle 126, inside back cover

Plastic-Enclosed Thermostat—Bulletin MC137, 4 pp. Describes two types of units which are encased in plastic for service in highly humid or

(Continued on page 315)


new AMP wire splice team
cuts costs in
aircraft and
electronic industries.
One-piece construction and precision tooling cuts application time to absolute minimum while guaranteeing perfect, permanent mechanical and electrical connections.
Three and one-half years of engineering research have developed the following features:
Color Coding at both connector and tooling
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Rectangular center window
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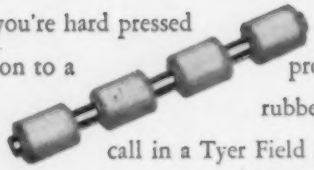
Oriental Terminal Products Co., Ltd., Tokyo, Japan

If you're hard pressed for the solution to a  problem in molded rubber, your best bet is to call in a Tyer Field Engineer. He will show you how Tyer's extensive technical knowledge and specialized experience have been put to work for other companies, and how they can help you, too.

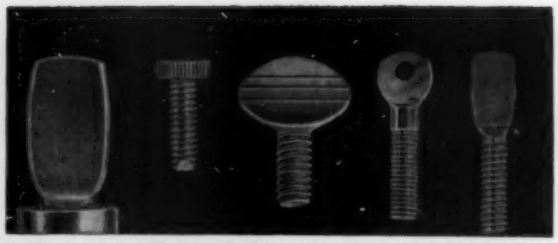
Our 100th TYER Anniversary

Tyer *Rubber Company*

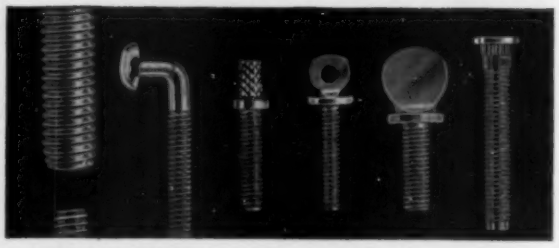
ANDOVER, MASSACHUSETTS, U. S. A.

TYER RUBBER COMPANY PE-12
Industrial Division, Andover 95, Massachusetts
Gentlemen:
☐ Please send me the new *Tyer Rubber Engineering Brochure* including technical specifications and relative properties of natural and synthetic rubbers.
☐ Please have Tyer field engineer call on_____ (date) No obligation, of course.

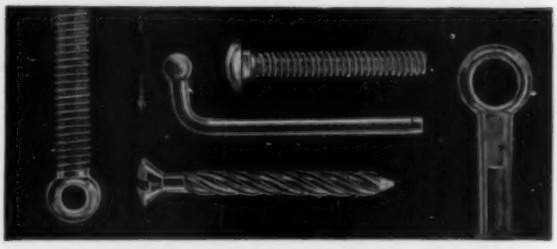
NAME_____
FIRM_____
STREET_____
CITY_____ ZONE____ STATE_____



YOU CAN'T BEAT COLD FORMING



FOR PARTS LIKE THESE—AND



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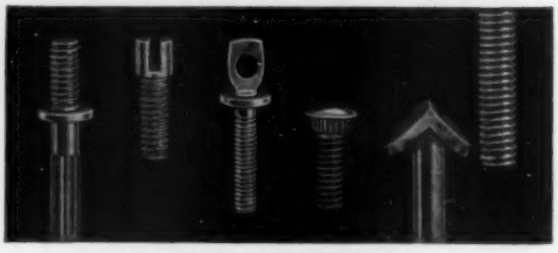
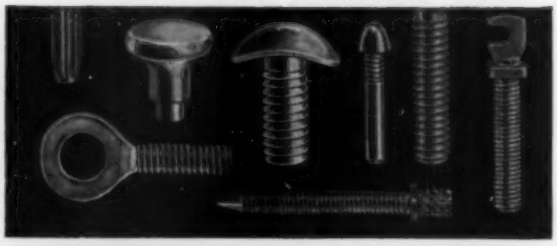


FOR COLD FORMING . . .



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. . . INCLUDING SQUARE AND HEXAGON MACHINE SCREW NUTS

WRITE FOR OUR CATALOG

THE PROGRESSIVE MANUFACTURING COMPANY
Division of The Torrington Company
48 NORWOOD ST., TORRINGTON, CONN.

corrosive environments. Fenwal Inc., Ashland, Mass.

Circle 127, inside back cover

Hydraulic-Magnetic Circuit Breakers—Bulletin 3411, 20 pp. Contains data on design, operation, application diagrams and time-dalay curves. Heinemann Electric Co., 725 Plum St., Trenton 2, N. J.

Circle 128, inside back cover

SAE Boss Fittings—Catalog, 11 pp. Contains data on fittings and "O" ring adapters. Anchor Coupling Co., Inc., 325 North Fourth St., Libertyville, Ill.

Circle 129, inside back cover

Modified Balls—Bulletin FB-1, 2 pp. Contains data on machining methods and materials. Industrial Tectonics, Inc., Ann Arbor, Mich.

Circle 130, inside back cover

Self-Locking Socket Screws—Booklet, 16 pp. Describes and illustrates the Nylok principle and gives examples of applications in which the vibration-proof screws can be used to eliminate the need for lock washers, wired heads or other extras. Standard Pressed Steel Co., Box 545, Jenkintown, Pa.

Circle 131, inside back cover

Weld Fasteners and Adjusting Screws—Bulletin 563, 6 pp. Contains charts and dimensional information. Ohio Nut and Bolt Co., 33 First Ave., Berea, Ohio.

Circle 132, inside back cover

Bulb-And-Capillary Temperature Controllers—Brochure MC139, 4 pp. Contains diagrams and data. Fenwal Inc., Ashland, Mass.

Circle 133, inside back cover

Potentiometers—Brochure, 6 pp. Contains data on multi-turn and single-turn models of wire-wound units. Electromath Corp., 190 Henry St., Stamford, Conn.

Circle 134, inside back cover

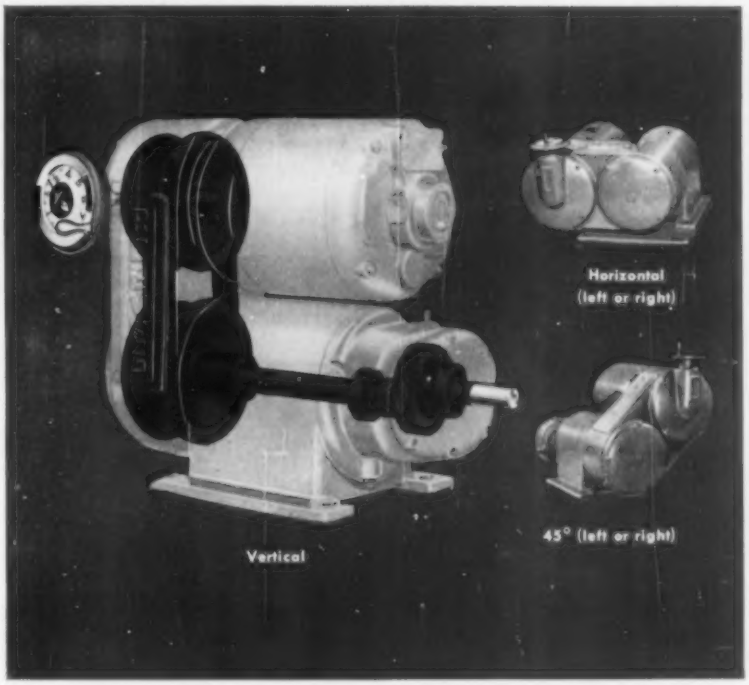
Steel Pipe, Tubing and Welding Fittings—Brochure TDC 146A, 4 pp. Contains data and charts. Babcock & Wilcox Co., Beaver Falls, Pa.

Circle 135, inside back cover

Plunger-Type Mercury Relays—Folder, 10 pp. Contains diagrams, data and charts on miniature, standard and

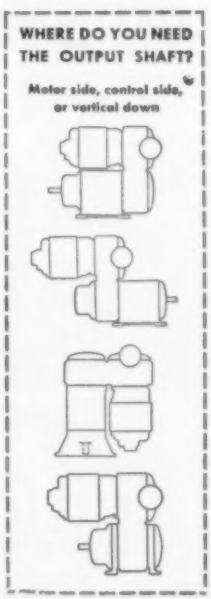
(Continued on page 317)

Variable Speed—Styled For Compact Machine Designs



REEVES

FRACTIONAL *Vari-Speed* MOTODRIVE



▶ REEVES fractional hp. Motodrive is a complete power package, engineered in over 100 assemblies to fit wherever your design calls for variable speed.

Choose from vertical, 45° or horizontal models in ¼ to 1 hp. . . . get stepless accurate speeds—within a 2:1 to 10:1 range—from as low as 3 rpm to a maximum of 4660 rpm.

Available in standard, weather resistant, totally enclosed or splash-proof enclosures; full range of manual or automatic controls.

REEVES Motodrive—the *right* speed for *every* need . . . in *any* place.

Write Dept. K23C-M54 for ratings and dimensions.

REEVES PULLEY COMPANY
Division of **RELIANCE** ELECTRIC AND ENGINEERING CO.
Columbus, Indiana

how to prevent radiator failure

▶ Engine vibration plus shock and distortion—*not corrosion*—are the principal causes of radiator failure on heavy-duty vehicles. They attack the radiator's core, tubes and fins, causing costly damage. Expected service life of an inadequately mounted radiator averages three to six months—in extreme cases failure occurs in the first few days.

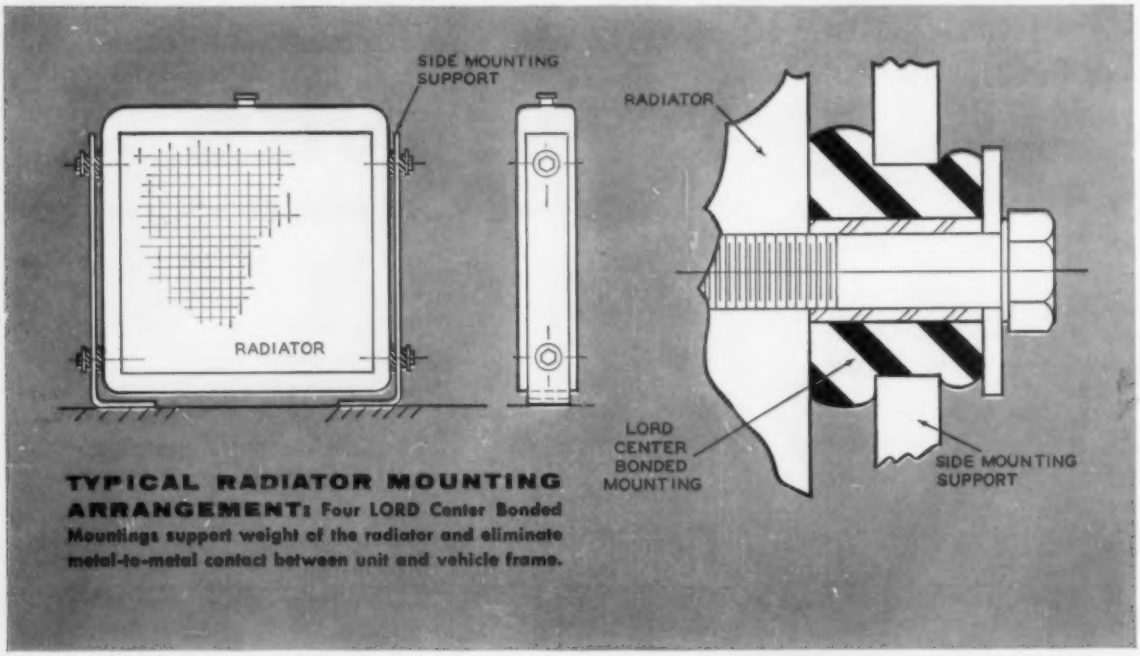
LORD Bonded Rubber Mountings prevent metal fatigue and damage from engine vibration or operational shocks. These rugged mountings are flexible enough to accommodate distortion and twisting—yet rigid enough to provide stability.

Radiator service life can be indefinitely extended by using LORD mountings. Radiators on a widely used type of farm equipment failed in six to ten working hours when inflexibly mounted. Now, with the radiators protected from engine vibration by LORD mountings, no failures have been reported in over 10,000 installations.

The success of LORD radiator mountings is the result of LORD's experience as specialists in engineered vibration control and bonded rubber products. If you have a problem involving vibration, shock or noise, contact a LORD Field Engineer or the Home Office in Erie, Pa., today.

HERE'S WHERE LORD MOUNTINGS CAN GREATLY INCREASE RADIATOR LIFE

- Tractors
- Power Shovels
- Hay Balers
- Bulldozers
- Scrapers
- Motor Cranes
- Carry-alls
- Off-highway Trucks
- Oil-field Engines
- Highway Trucks
- Engine-generator Sets



TYPICAL RADIATOR MOUNTING ARRANGEMENT: Four LORD Center Bonded Mountings support weight of the radiator and eliminate metal-to-metal contact between unit and vehicle frame.

ATLANTA, GEORGIA · CEdar 7-1123
BOSTON, MASS. · HAncock 6-9135
CHICAGO, ILL. · Michigan 2-6010
CLEVELAND, OHIO · SHadyside 9-3175
DALLAS, TEXAS · Riverside 3392
DAYTON, OHIO · Michigan 8871
DETROIT, MICH. · TRinity 4-2060
LOS ANGELES, CAL. · HOllywood 4-7593
NEW YORK, N. Y. · Circle 7-3326
PHILADELPHIA, PA. · LOcust 4-0147

"In Canada—Railway & Power Engineering Corporation Limited"

LORD MANUFACTURING COMPANY · ERIE, PA.

LORD BONDED RUBBER

designers and producers of bonded rubber products since 1924

heavy duty units. Ebert Electronics Corp., 212-26 Jamaica Ave., Queens Village 28, N. Y.

Circle 136, inside back cover

Universal Joints–Catalog, 8 pp. Contains data, drawings and specifications. Detroit Bevel Gear Co., 8130 Jos. Campau, Detroit 11, Mich.

Circle 137, inside back cover

Miniature Voltmeter–Data sheet, 1 pp. Contains specifications on expanded scale a-c units. International Instruments Inc., P. O. Box 2954, New Haven 15, Conn.

Circle 138, inside back cover

Gas Thermostat–Bulletin RT-814, 4 pp. Contains data on unit designed to provide up to 66,000 BTU hourly capacity on manufactured gas, 97,500 BTU on natural gas and 210,000 BTU on LP gas. Robertshaw-Fulton Controls Co., 410 E. Otterman St., Greensburg, Pa.

Circle 139, inside back cover

Metal Boxes, Cases, and Containers–Catalog, 60 pp. Contains data on over 1400 deep-drawn cases of aluminum, brass and steel. Zero Mfg. Co., 1121 Chestnut St., Burbank, Calif.

Circle 140, inside back cover

Accessory Temperature Controls–Brochure MC 132, 6 pp. Describes miniaturized units designed for aircraft, guided missiles and related applications requiring control in confined spaces. Fenwal Inc., Ashland, Mass.

Circle 141, inside back cover

Electrical Terminal Blocks and Kits–Catalog 556, 4 pp. Contains descriptions, specifications and prices. Curtis Development & Mfg. Co., 3250 No. 33 St., Milwaukee 16, Wis.

Circle 142, inside back cover

Corrosion-resistant Fastenings–Brochure, 24 pp. Contains diagrams, data and chart on stainless steel and non-ferrous fastenings. H. M. Harper Co., Morton Grove, Ill.

Circle 143, inside back cover

Precision Relays–Data sheets (2) contain information on units starting at 5 milliw per contact up to several watts, and available for either a-c or d-c applications in contact combinations from single-pole, single throw

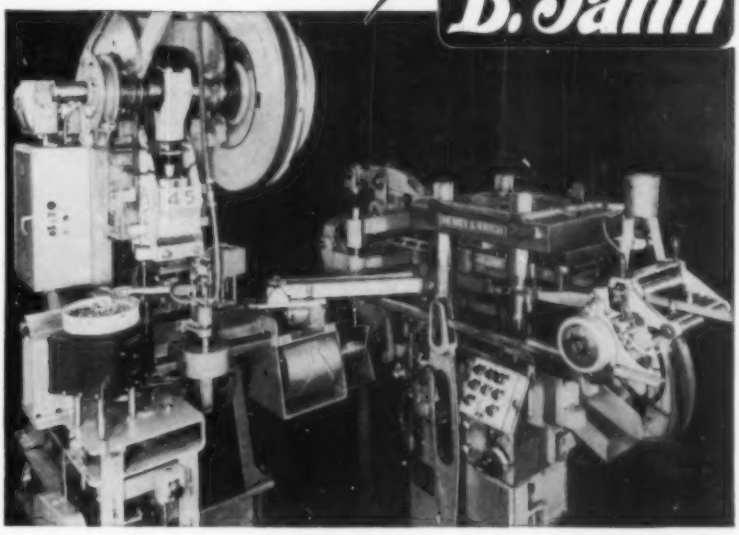
(Continued on page 319)

2 PRESSES . . . 1 PROGRESSIVE DIE . . . 1 STIPPLING DIE . . . ENGINEERING INGENUITY . . . SPECIAL MACHINERY . . . SPECIAL ELECTRICAL COMPONENTS . . .

produce

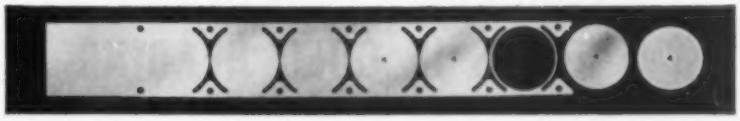
AUTOMATION

by **B. Jahn**



Here's true automation — 100% automatic production, 100% B. Jahn built, that transforms .025" aluminum into precise meter components 3⅝" in diameter — each with 720 teeth .009" deep — without human hands, human error!

Equipped with B. Jahn progressive die, one 60 ton press was linked by a chain drive to a 45 ton press incorporating a stippling die.



Progressive die, ground all over to guarantee greater accuracy, longer service, less downtime, pierces and blanks intricate discs.

Conveyor system feeds disc into air-operated vacuum arm that positions piece in B. Jahn stippling die. Another arm removes stippled piece and places it on stacking unit.

Completed discs, at the rate of 30 per minute, are automatically stacked and spaced on spindle. Here's true AUTOMATION. true production economy!

Get Full Details On This Astounding "No Hands . . . No Delay . . . No Error" Automation Application — Send Today for the Big New B. Jahn Brochure.

B. Jahn

THE B. JAHN MANUFACTURING COMPANY, NEW BRITAIN, CONNECTICUT

Is your part illustrated? These are representative of the shapes that can be cold formed more effectively with Granodraw.

GRANODRAW® PROCESS INCREASES TOOL LIFE 2-5 TIMES IN COLD HEADING STEEL FASTENERS

Thorough research, in cooperation with a leading manufacturer of headed fasteners, has proved the value of Granodraw phosphate coating of stock prior to cold working. Typical of the improvement in tool life and in production are the examples shown in the table.

But the advantages do not stop here in cold heading fasteners or cold working other products. This chemical treatment process permits greater speed of draw; greater reductions within the physical limits of the metal; more passes with the same number of intermediate treatments; and the possibility of fewer process anneals. It also results in less downtime of machines, better surface finish on products, cold forming of more complex shapes, fewer rejects, and a cleaner shop.

Write us for complete information about Granodraw and its application in cold forming operations.

PRODUCTION AND TOOL LIFE

PRODUCT	MATERIAL		AV. PIECES PER DIE DRESSING	
	Tool	Stock	Granodraw-Treated	Other Treatment
⅜ x ⅞ rivet	Hardened Alloy Steel	1010 Steel	647,000	180,500
5/16 x 24 flat head shoulder bolt	Hardened Alloy Steel	1010 Steel	26,000	5000-8000
Hex Head Cap Screws	Hardened Alloy Steel	1038 Steel	53,000	13,000-14,000
¼ x 20 Hex Machine Bolt	Hardened Alloy Steel	1018 Steel	28,000	13,000

Note. Although investigations on the life of carbide tools are not completed, one item deserves mention. A 5/16 x 24 hex head shoulder bolt showed a strikingly low carbide tool life of 67,000 pieces per die. Using Granodraw-treated rod, one die produced 105,000 pieces—another 194,000 pieces. And both dies were in good condition at the end of the run.

AMERICAN CHEMICAL PAINT COMPANY, Ambler 17, Pa.

DETROIT, MICHIGAN ST. JOSEPH, MISSOURI NILES, CALIFORNIA WINDSOR, ONTARIO

CHEMICALS ACP PROCESSES

to triple-pole, double throw. Hedin Tele-Technical Corp., 87 Dorsa Ave., Livingston, N. J.

Circle 144, inside back cover

Special Copper Alloys–Pamphlet, 1 pp. A listing of non-standard, wrought copper base alloys. Copper & Brass Research Asso., 420 Lexington Ave., New York 17, N. Y.

Circle 145, inside back cover

Comparative Chemical Resistance of Fibers–Bulletin X-48, 26 pp. Contains data and charts on chemical effects on fiber properties. E. I. Du-Pont De Nemours & Co., Wilmington, Del.

Circle 146, inside back cover

Comparative Heat Resistance of Fibers–Bulletin X-56, 8 pp. Contains data on fiber testing and exposure methods. Also comparative heat exposure charts. E. I. Du Pont De Nemours & Co., Wilmington, Del.

Circle 147, inside back cover

Precision Ball Bearings–Catalog, 64 pp. Contains characteristics, data and charts on torque, performance and selection. Barden Corp., Danbury, Conn.

Circle 148, inside back cover

Photoelectric Controls–Bulletin, 15 pp. Contains data on moderate, ultra-sensitive, high-speed and impulse-actuated units. Autotron, Inc., Box 722-V, Danville, Ill.

Circle 149, inside back cover

Flexible Chain Couplings–Catalog, 16 pp. Contains specifications, dimensions, ratings and applications. Morse Chain Co., Ithaca, N. Y.

Circle 150, inside back cover

Fhp Motors–Data sheet, 2 pp. Contains information on 1/300 to ¼ hp motors from 2 to 230v. Boehm Co., Merrick, L. I., N. Y.

Circle 151, inside back cover

Shoe Brakes–Bulletin BD-12, 5 pp. Contains data on construction and performance of heavy duty unit. Fawick Corp., Cleveland, Ohio

Circle 152, inside back cover

Welded and Cold Drawn Tubing–Data Memorandum. Contains information on tubing made by forming cold-rolled strip into tubing, fusion

(Continued on page 320)

More and More Manufacturers are Installing

MARVEL SYNCLINAL FILTERS

AS STANDARD EQUIPMENT

Manufacturers of hydraulically actuated equipment and others with low pressure liquid circulating systems demand their equipment to perform consistently with all the productive efficiency they build into the machine that bears their name. Since these systems must be kept free of damaging particles, the selection of a filter is an important factor. Here are some of the outstanding reasons for the increasing preference for Marvel Synclinal Filters to do this all-important job!

SUMP TYPE (cutaway)

BECAUSE . . . Marvels are designed to give maximum ACTIVE filtering area rather than total filtering area. Only ACTIVE FILTERING AREA COUNTS!

BECAUSE . . . Marvels greater storage space for filtered out particles allows longer periods of "production" time at absolute minimum in maintenance cost and "down-time."

BECAUSE . . . Marvels can be disassembled, cleaned and reassembled by any workman in a matter of minutes. Line type operates in any position and may be serviced without disturbing pipe connection.

BECAUSE . . . Marvels are protected and of sound construction to give long life and efficient filtration. THEY MEET J. I. C. STANDARDS.

BECAUSE . . . Marvels (Both Sump and Line Type) are available in individual capacities from 5 to 100 G.P.M. and choice of mesh sizes ranging from coarse 30 to very fine 200, they get a filter to fit their specific requirements.

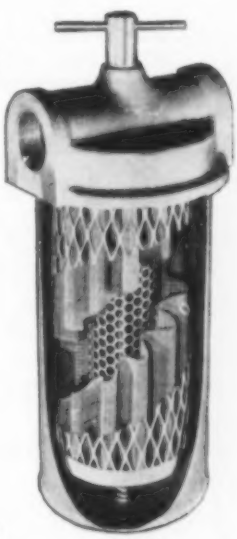
BECAUSE . . . Marvel not only delivers a top grade filter in both quality and performance, but delivers IMMEDIATELY—shipments are made the same day orders are received, if desired.

FACTS—NOT CLAIMS

Engineers decide on the basis of the record, on the basis of measurable facts rather than claims of the "campaign promise" variety. Here is a fact with meaning—

OVER 700 O. E. M's

install MARVEL Synclinal FILTERS as Standard Equipment!



LINE TYPE (cutaway)

For Dependable Protection on All Hydraulic and Low Pressure Systems Investigate

MARVEL SYNCLINAL FILTERS

FILTERS FOR FIRE-RESISTANT HYDRAULIC FLUIDS

Marvel's most recent development is a filter for the efficient filtration of all types of fire-resistant hydraulic fluids.

WATER FILTERS

Both sump and line type filters have been adapted for use in all water filtering applications. No changes have been made in the basic, balanced synclinal design.

Catalogs containing complete data available on request

MARVEL ENGINEERING COMPANY

7227 N. Hamlin Ave., Chicago 45, Ill. PHONE: JUniper 8-6023

PE-12

Without obligation, please send me complete data on Marvel Synclinal Filters, as indicated:—

☐ Catalog #107—For Hydraulic Oils, Coolants, Lubricants
☐ Catalog #200—For Fire-resistant Hydraulic Fluids (Aqueous Base)
☐ Catalog #400—For Fire-resistant Hydraulic Fluids (Synthetic)
☐ Catalog #301—For Water

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Company .....

Address .....

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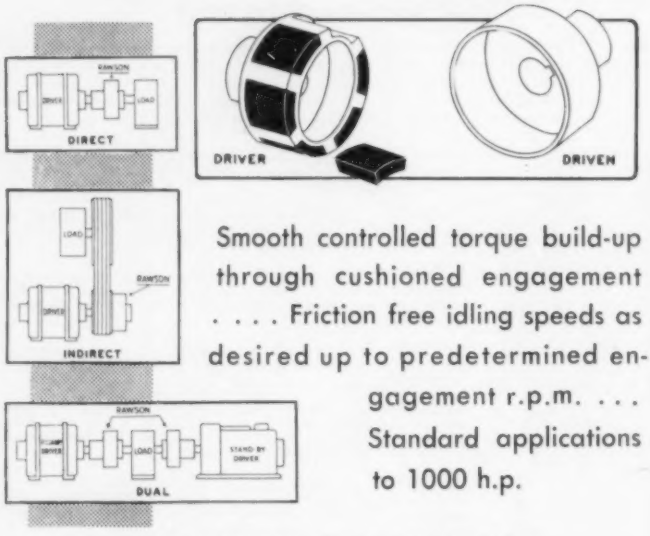
RAWSON® AUTOMATIC CENTRIFUGAL CLUTCH



Smooth controlled torque build-up through cushioned engagement . . . . Friction free idling speeds as desired up to predetermined engagement r.p.m. . . . Standard applications to 1000 h.p.

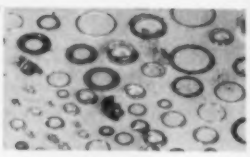
RAWSON COUPLINGS

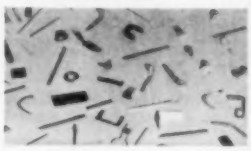
O. S. WALKER COMPANY, INC.

500 Rockdale St. • Worcester, Mass.

NEY'S SMALL PARTS PLAY A BIG PART IN PRECISION INSTRUMENTS • NEY'S SMALL PARTS

NEY





PRECIOUS METAL

ENGINEERED CONTACTS, SLIP RINGS & ALLOYS

Ney designs and makes to customers' specifications sliding contacts, slip rings and assemblies, commutator segments and assemblies, brush and brush holder assemblies, and precious metal resistance wire. Consult Ney's Engineering Dept. and find out how precious metals can improve your products.

THE J. M. NEY COMPANY, P.O. BOX 990, DEPT. J, HARTFORD 1, CONN.

Specialists in Precious Metal Metallurgy since 1812

Ney has just built this modern new plant to give you even better products and better service.

welding the edges and cold drawing to size. Superior Tube Co., 1556 Germantown Ave., Norristown, Pa.

Circle 153, inside back cover

Speed Reducers–Bulletin, 12 pp. Contains information on integral gear motors, speed reducers with separate motors, and speed reducers. Sterling Electric Motors, Inc., 5401 Telegraph Rd., Los Angeles 22, Calif.

Circle 154, inside back cover

Synthetic Rubber–Booklet, 26 pp. Contains data and charts which analyze the properties of cold non-oil polymers, cold oil-extended polymers, and hot polymers. Goodrich-Gulf Chemicals, Inc., 3121 Euclid Ave., Cleveland 15, Ohio

Circle 155, inside back cover

Nuclear Power Plants–Bulletin, 12 pp. Contains design data, heat balance diagram and characteristics chart. Alco Products, Inc., P. O. Box 1065, Schenectady, N. Y.

Circle 156, inside back cover

Gaskets, Shims and Washers–Catalog, 28 pp. Contains data on ring, cylinder head, double jacket, self-sealing and special types of gaskets. Chicago-Wilcox Mfg. Co., 7701 South Avalon Ave., Chicago 19, Ill.

Circle 157, inside back cover

Force Transducers–Bulletin 140, 2 pp. Contains data for dynamic or static measurement and control involving force, stress, weight, and torque. Daytronic Corp., 216 S. Main St., Dayton 2, Ohio

Circle 158, inside back cover

Adhesives, Coatings and Sealants–Brochure, 8 pp. Contains data and charts for bonding metals, wood, paper and synthetic materials. Angier Adhesives, 120 Potter St., Cambridge 42, Mass

Circle 159, inside back cover

Thermal Time Delay Relays–Brochures (2). Contains specifications, diagrams and charts on relays for control and timing applications. Curtiss-Wright Corp., 631 Central Ave., Carlstadt, N. J.

Circle 160, inside back cover

Leveling Jacks–Bulletin, 4 pp. Contains specifications on units for production machines, tool room equip-

(Continued on page 324)

Design "Low Cost" Into YOUR Equipment

GITS

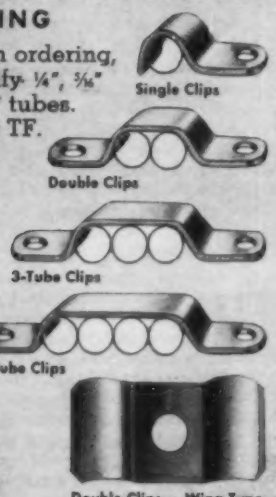
World's Largest Selection of Low-Cost Lubricating Devices

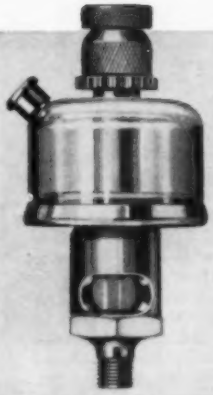
LUBRIKIT . . . An assortment of 95 oil cups of 29 different types. Gits sales records show these oilers are most used for replacement and maintenance. Contents of each separate bin are clearly described on Inside Cover.

Special Introductory Price
Just $14.95 F.O.B. Factory
Satisfaction or your money back

CLIPS FOR ATTACHING TUBING

When ordering, specify ¼", ⅜" or ¾" tubes. Style TF.





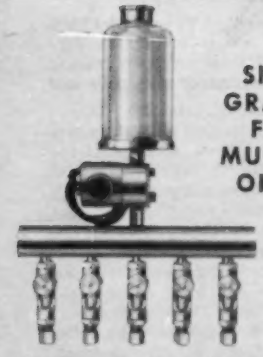
SIGHT GRAVITY FEED OILERS

Rate of oil flow regulated by needle valve, directly observed through sight glass in stem.

Shut-off knob does not affect needle valve adjustment. Visible oil supply. Non-breakable. Tops in convenience and dependability, at low cost. Style NFU—No. 3602-A.

GEAR CASE GAUGES

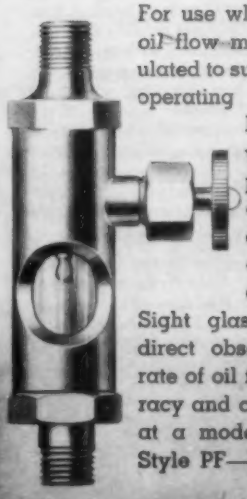
This oil gauge plug permits instant checking of oil level within a transmission or gear case. For use where construction permits insertion in tapped hole. A valuable addition to any such equipment — at very low cost. Style BW—No. 4042.



SIGHT GRAVITY FEED MULTIPLE OILERS

This one unit replaces 3 to 8 individual oilers. Maximum practicality in a small central lubrication system. Positive cut-off during idle periods. Individual vibration-proof needle valve adjustments. With solenoid control (Illustrated): Style MDS—No. 4685-A. Without solenoid: Style MD.

SIGHT GAUGES



For use where rate of oil flow must be regulated to suit changing operating conditions. Needle valve permits extremely accurate adjustment of oil feed. Sight glass provides direct observation of rate of oil flow. Accuracy and convenience at a moderate price. Style PF—No. 4290.

Don't price yourself out of the market. When you design proper lubrication into your equipment, specify GITS Lubricating Devices—the widest selection available anywhere. The items pictured above are only a few of our many thousands of lubricating devices. At the design stage, get the GITS story. Free Engineering Service. Send NOW for your free Catalog.

GITS BROS. MFG. CO.

The Standard For Industry For Almost Half A Century

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Chicago 23, Illinois

Clip this page for handy "rough reference"

(Advertisement)

SPECIAL REPORTS ON FINISHING NON-FERROUS METALS

NUMBER III—Lustrous, Corrosion-Resistant Finishing with Chemical Polishing Iridite

WHAT IS IRIDITE®

Briefly, Iridite is the tradename for a specialized line of chromate conversion finishes. They are generally applied by dip, some by brush or spray, at or near room temperature, with automatic equipment or manual finishing facilities. During application, a chemical reaction occurs that produces a thin (.00002" max.) gel-like, complex chromate film of a non-porous nature on the surface of the metal. This film is an integral part of the metal itself, thus cannot flake, chip or peel. No special equipment, exhaust systems or specially trained personnel are required.

Chromate conversion coatings are widely accepted throughout industry as an economical means of providing corrosion protection, a good base for paint and decorative finishes for non-ferrous metals. Certain of these coatings also possess chemical polishing abilities that have luster-producing, as well as corrosion-inhibiting, effects on zinc and cadmium plate, zinc die castings and copper alloys. However, continued developments in this field have been so rapid that many manufacturers may not be completely aware of the breadth of application of this type of finish. Hence, this discussion of the many ways in which this chemical polishing characteristic can be used in final finishing or pre-plating treatments to produce a lustrous appearance with distinct display and sales appeal and appreciable savings in cost. Report I on decorative, corrosion-resistant finishes and Report II on paint base corrosion-resistant finishes are available on request.

The degree of luster possible on a surface is a function of the degree to which the surface can be smoothed. Leveling to provide a smooth surface can be achieved by mechanical or chemical means, or a combination of these, depending upon the luster desired and the original condition of the metal. Chemical polishing effectively imparts luster otherwise difficult and costly to obtain. For this reason, it is often used to supplement or entirely replace mechanical polishing, depending upon the application and the original condition of the metal. Chemical polishing has the additional advantage of providing overall treatment of the submerged part. It reaches into even the deepest corners and recesses that are otherwise inaccessible. Certain of the Iridites are specifically designed to perform this chemical polishing operation. Also, they provide corrosion protection as do all Iridites, thus may be used as a final finish or a pre-plating polish.

If Iridite is to be used as a final finish, in contrast to pre-plating treatment, the chromate conversion coating generated is allowed to remain, providing good corrosion resistance. Color inherent in these Iridite films ranges from a yellow cast to yellow iridescent. These coatings may be used without further treatment where this color is acceptable and good corrosion resistance is desired. Further, these basic coatings can be tinted by dyeing. Among the dye tints available are shades of red, yellow, blue and green. If desirable, the basic coatings can also be modified by a bleach dip leaving a clear bright or blue iridescent finish. In all cases bleaching reduces corrosion resistance.

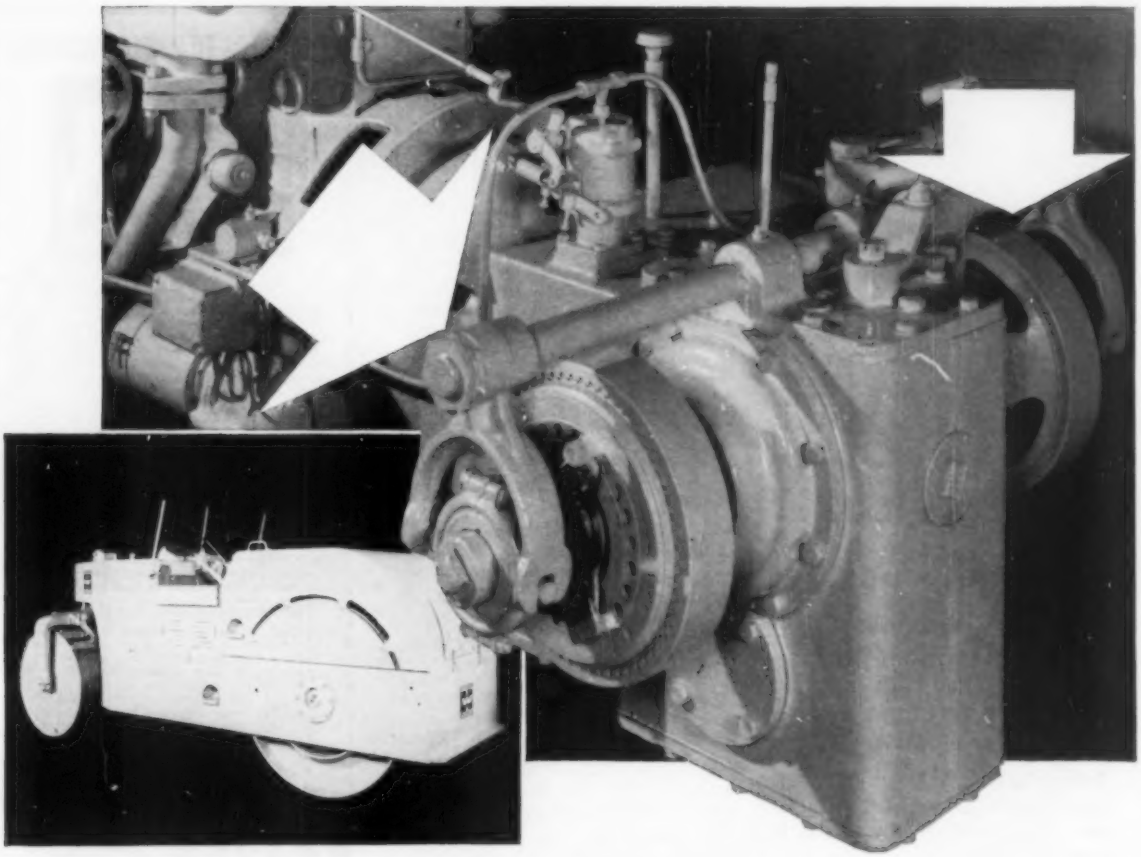
As examples of this type of final finishing, Iridites #4-73 and #4-75 (Cast-Zinc-Brite) make possible for the first time, lustrous chemical polishing of the as-cast surface of zinc die castings. Thus, in many cases, sizeable savings in finishing cost are realized by elimination of plating costs. This economical method can be used on tools, appliance parts, toy pistols, locks and many other small castings. Another example is the treatment of copper and brass parts, such as welding tips, to eliminate buffing and provide additional corrosion resistance. In many cases, handling costs are reduced appreciably by replacing piece-part handling with bulk processing. Still another example of the use of this chemical polishing and protective quality of Iridite is a simple system of zinc plate, Iridite and clear lacquer instead of more costly electroplated finishes. Typical of this type of lustrous finish are builders hardware and wire goods.

As a pre-plating treatment, in contrast to final finishes, Iridite can be used to chemically polish zinc die castings or copper prior to plating. In such cases, Iridite should be applied as an in-process step, so that the protective film is removed before the plating cycle. The savings in handling, material and labor costs are obvious. This process has made it practical to plate chrome directly over copper on steel, conserving nickel, yet producing a lustrous chrome finish. Used after stripping faulty plate in reprocessing zinc die castings, Iridite restores luster to the casting, thus making possible replating without blistering.

Other Iridite finishes are available to produce maximum corrosion resistance, a wide variety of decorative finishes and excellent bases for paint on all commercial forms of the more commonly used non-ferrous metals. As a final finish, appearance ranges from clear bright to olive drab and brown and many films can be bleached or dyed. As a paint base Iridite provides excellent initial and retentive paint adhesion and a self-healing property which protects bare metal if exposed by scratching. Iridites have low electrical resistance. Some can be soldered and welded. The Iridite film itself does not affect the dimensional stability of close tolerance parts.

Iridites are widely approved under both Armed Services and industrial specifications because of their top performance, low cost and savings of materials and equipment.

You can see then, that with the many factors to be considered, selection of the Iridite best suited to your product demands the services of a specialist. That's why Allied maintains a staff of competent Field Engineers—to help you select the Iridite to make your installation most efficient in improving the quality of your product. You'll find your Allied Field Engineer listed under "Plating Supplies" in your classified telephone book. Or, write direct and tell us your problem. Complete literature and data, as well as sample part processing, is available. Allied Research Products, Inc., 4004-06 East Monument Street, Baltimore 5, Maryland.



New HUBER-WARCO Tandem Rollers *STANDARDIZE* on TWIN DISC CLUTCHES!

To obtain smooth, trouble-free control of forward and reverse, the Huber-Warco Company *standardized* on Twin Disc Model CL Clutches for their new line of medium and large size variable weight tandem rollers.

Four models are included in the new line—the medium sized 5-8 and 8-10 ton rollers and the large 8-12 and 10-14 ton tandems—all of identical design.

Rugged, heavy-duty, fully-enclosed Twin Disc Model CL Clutches were designed into each model for several important reasons. They are unusually compact . . . provide easy, single point adjustment . . . designed for smooth acceleration, and take hold without grabbing . . . excess clamping force assures a firm grip when the clutch is fully engaged . . . provide excellent heat absorption and dissipation ability to protect the clutch faces from damage or distortion.

For these reasons, Huber-Warco has *standardized* on Twin Disc Clutches for the past 13 years. If *you* want a smooth, dependable transmission of power to *your* equipment, get all the facts on the Twin Disc Model CL Clutches—offered with one, two or three friction plates, in sizes from 5.5" to 11.5". Write Twin Disc Clutch Company, Racine, Wis. Request Bulletin 120-D.

TWIN DISC Clutches

TWIN DISC CLUTCH COMPANY, Racine, Wisconsin • HYDRAULIC DIVISION, Rockford, Illinois

BRANCHES OR SALES ENGINEERING OFFICES: CLEVELAND • DALLAS • DETROIT • LOS ANGELES • NEWARK • NEW ORLEANS • TULSA

ment, large surface plates and assembly fixtures. Enterprise Machine Parts Corp., 2731 Jerome at McNichols Road, Detroit 12, Mich.

Circle 161, inside back cover

Precision Valves–Brochure, S-2021R, 4 pp. Contains data and diagrams on check, shuttle, relief and shut-off valves. Circle Seal Products Co., 2181 E. Foothill Blvd., Pasadena, Calif.

Circle 162, inside back cover

Molded Plastics–Brochure, 8 pp. Contains data, applications, and property chart of 13 materials. Richardson Co., 27 Ave. and Lake St., Melrose Park, Ill.

Circle 163, inside back cover

Conveyor, Elevator and Transmission Belting–Catalog, 32 pp. Contains information and charts. Boston Woven Hose & Rubber Co., Boston 3, Mass.

Circle 164, inside back cover

Problems Affecting National Defense–Brochure, 6 pp. Supplement to '54 listing of problems on which governments invites assistance of individuals and companies. Contains 35 new technical problems. NIC, U. S. Dept. of Commerce, Washington 25, D. C.

Circle 165, inside back cover

Metals, Contacts and Assemblies–Catalog, 12 pp. Contains data on clad, thermostat, industrial, solid and clad precious metals, electrical contacts and complete assemblies. Metals and Controls Corp., Attleboro, Mass.

Circle 166, inside back cover

Air Cylinders–Catalog 110, 11 pp. Contains data on valves and cylinders ranging from 1½ through 14 in. in bore sizes. S-P Mfg. Corp., 30201 Aurora Rd., Solon, Ohio

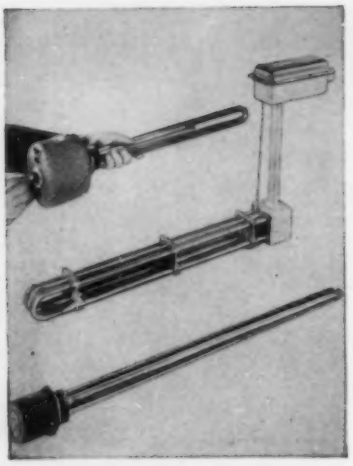
Circle 167, inside back cover

Casters–Brochure, 4 pp. Contains data on 40 models of medium and light duty units, as well as solid rubber, semi-pneumatic and full pneumatic wheels. Gleason Corp., Dept. 412, 250 N. 12 St., Milwaukee 3, Wis.

Circle 168, inside back cover

Rotary Gear Pumps–Catalog, 14 pp. Contains data on viscosities and pipe velocities of pump sizes from ¼ to

(Continued on page 338)



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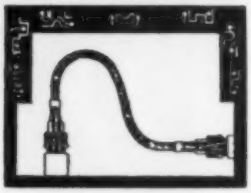

More flexible shafts are being used in the electronic field today because they offer an economy in time, space, and costs.
There are three types of flexible shafts available, each having certain advantages.

The **FIRST** type of flexible shaft is power drive, which transmits power between two points where, due to position, solid shafts cannot be used. The power drive flexible shaft provides for rotation either clockwise or counter-clockwise with the wire wound according to the direction rotation in order to strengthen the cable while the assembly is in use.

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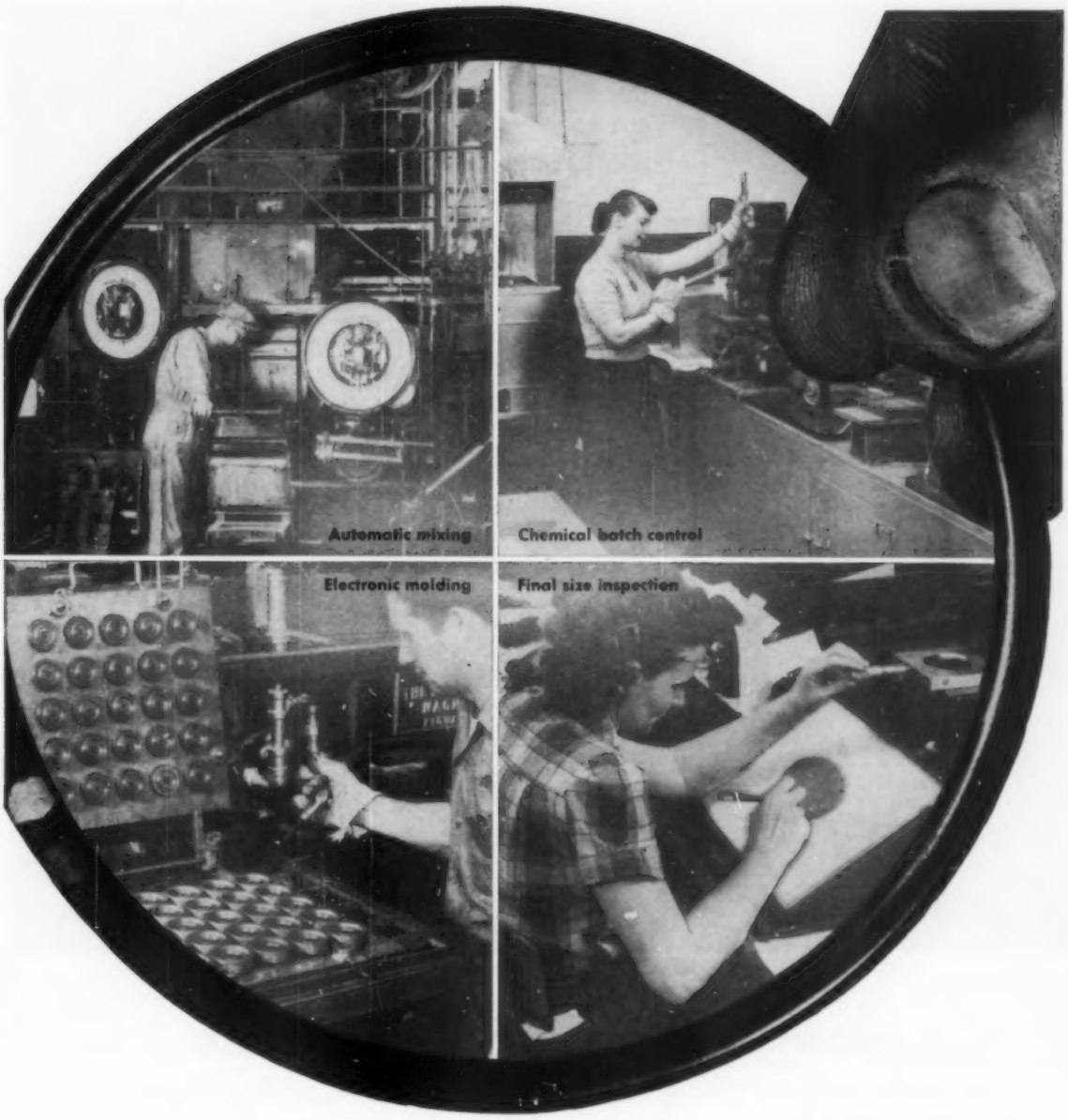

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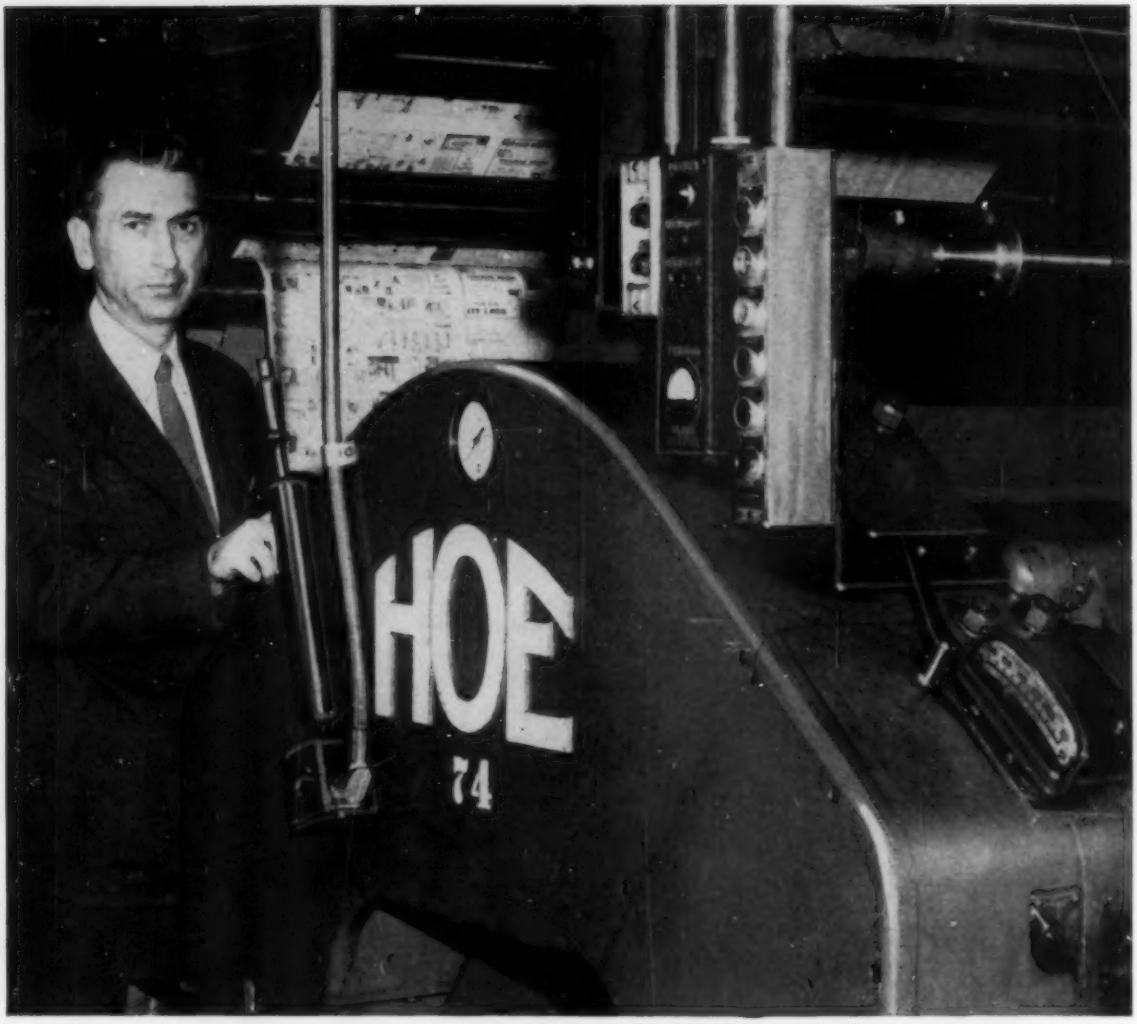

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Here is the new R. Hoe & Co., Inc., black press at the Los Angeles Times getting a final examination by SKF's Senior Division Engineer Paul W. Dunlap before it starts regular operations. Representing an entirely different concept of design, this press includes 16 black printing units, each of 16-page capacity, and two double folders, with provision for a variable number of color couples.

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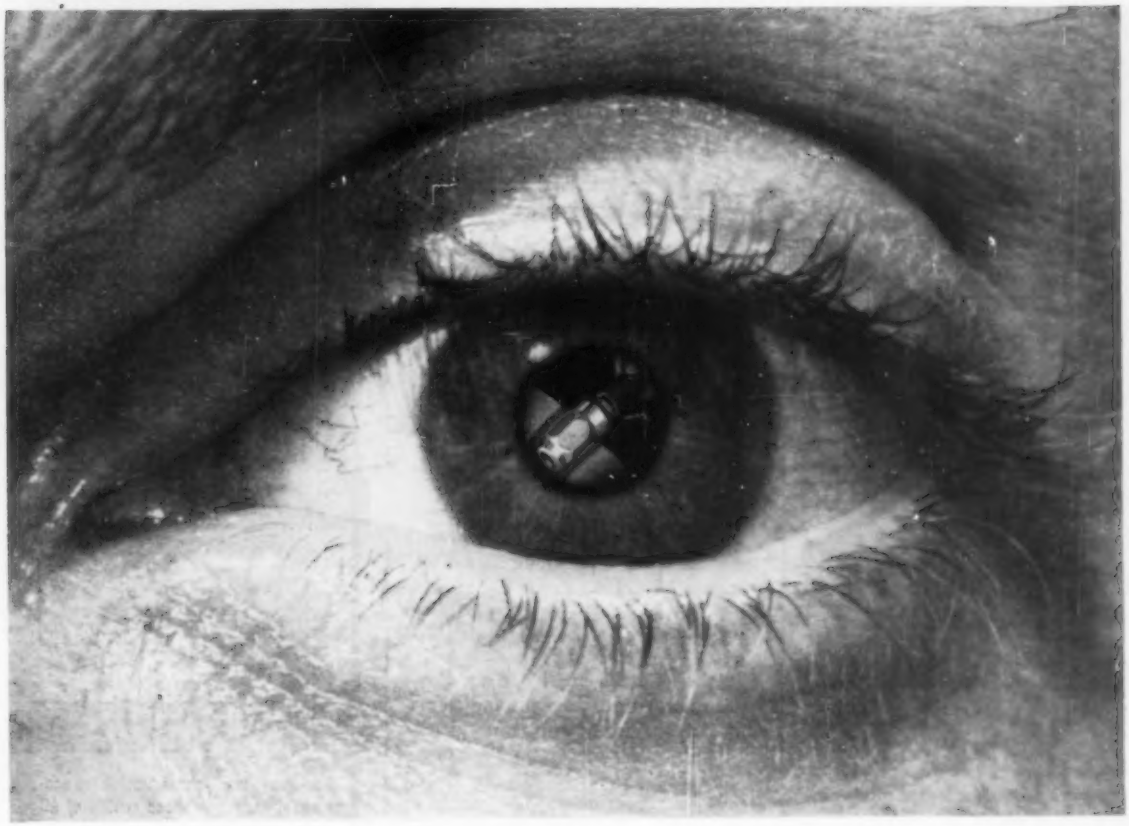

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Here, from one convenient source, you can get the most advanced hydraulic fittings available . . . both tube *and* hose. For example, new Parker *no-skive* Hoze-lok fittings require no stripping of rubber-covered hydraulic hose. They're faster, easier to use and *re-usable*.

Also, new Parker *straight-thread* tube fittings solve high-pressure hydraulic leakage problems resulting from tapered pipe threads. *Straight* threads are available on Triple-lok (the industrial standard flare tube fitting) and on Ferulok (flareless fitting for heavy steel tubing).

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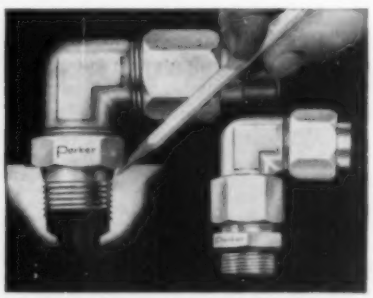

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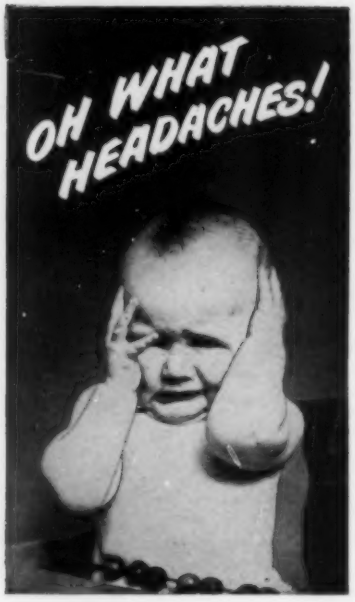

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Catalogs and Bulletins . . . . . continued

146 gpm. Northern Ordnance Inc., Dept. 106, Columbia Heights Station, Minneapolis, Minn.

Circle 169, inside back cover

Static Control Elements–Bulletin GEA 6578, 8 pp. Contains data and diagrams on units that operate without moving parts. General Electric Co., Schenectady 5, N. Y .

Circle 170, inside back cover

Adhesives for Polyester Film–Bulletin, 7 pp. Contains data on modified rubber and vinyl types of adhesives. E. I. Du Pont De Nemours & Co., Wilmington, Del.

Circle 171, inside back cover

Drafting Instruments–Catalog, 12 pp. Contains data on lettering instruments, T-squares and templates. Dolgorukox Mfg. Co., Fisher Bldg., Detroit 2, Mich.

Circle 172, inside back cover

Clutches–Catalog 104-C, 26 pp. Contains information, diagrams and charts on clutches for over-running, backstopping and indexing. Formsprag Co., 23601 Hoover Road, Van Dyke, Mich.

Circle 173, inside back cover

Letterhead Requests Only

Manufacturers who published following literature ask that requests for copies be made on company letterheads.

Titanium Alloys–Booklet, 30 pp. Contains information on the measurement of thermal stability. Includes data on the effects of stress, strain, temperature, and surface contamination upon stability. Titanium Metallurgical Lab., 505 King Ave., Columbus 1, Ohic

Cobalt and Its Alloys –Booklet, 100 pp. Contains a summary on allotropy and phase diagrams as well as several hundred references to cobalt literature. Cobalt Information Center, Battelle Institute, Columbus, Ohio

Digital Design–Booklet, 15 pp. Contains information on the use of digital techniques for testing, information handling, and control. Burroughs Corp., 1209 Vine St., Philadelphia 7, Pa.

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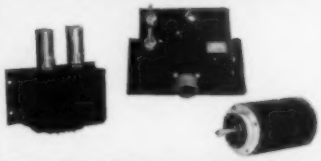

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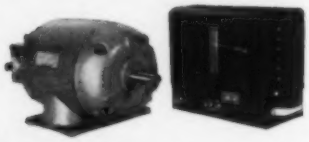

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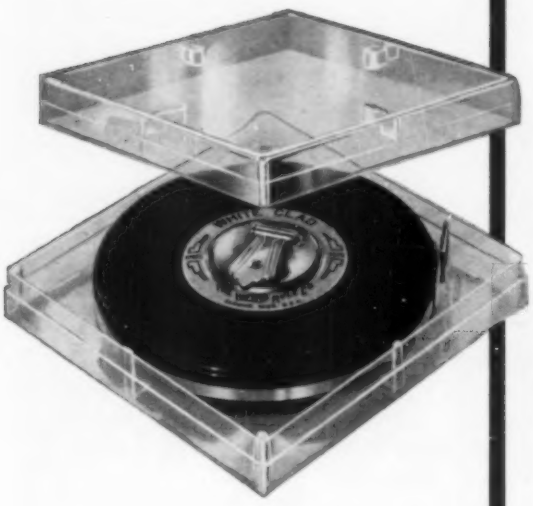

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what was done about it: Lufkin discussed their problem with The Richardson Company who designed a new, clear polystyrene case. Richardson engineers developed a friction fit, requiring extremely close molding techniques, which eliminated the need for hinges or locks. This, in turn, eliminated the need for undercuts which would have increased mold costs.

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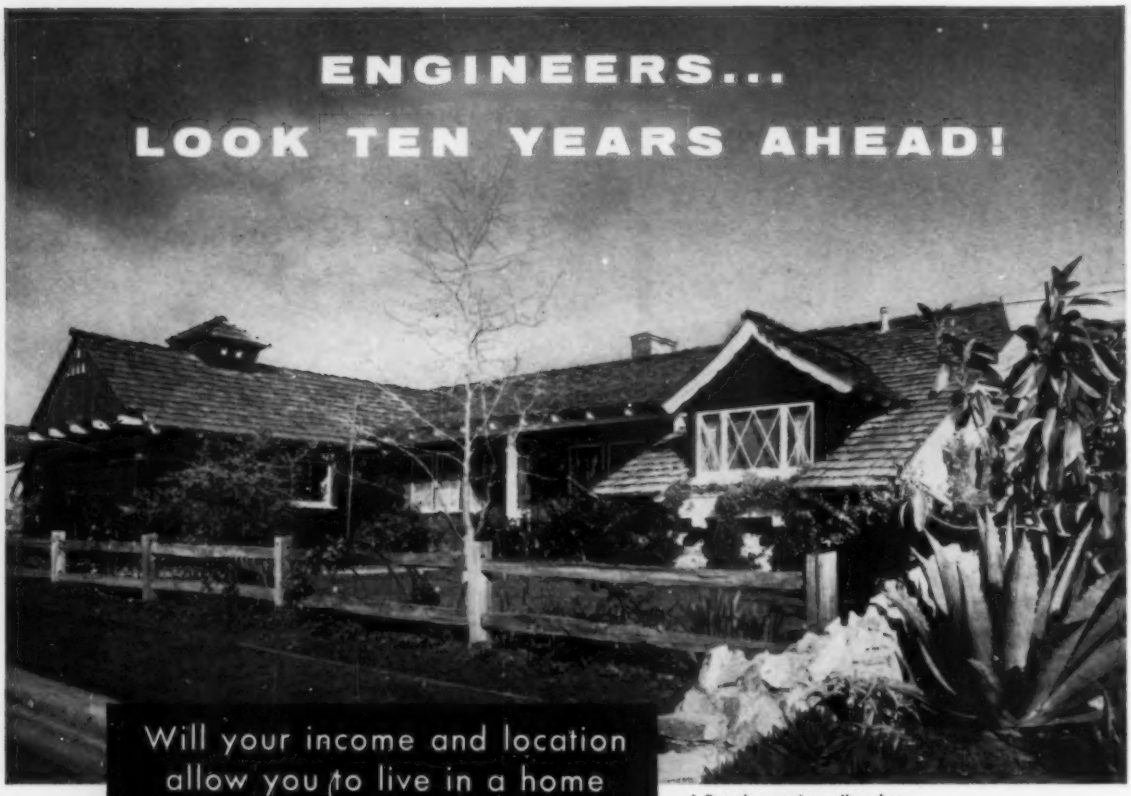

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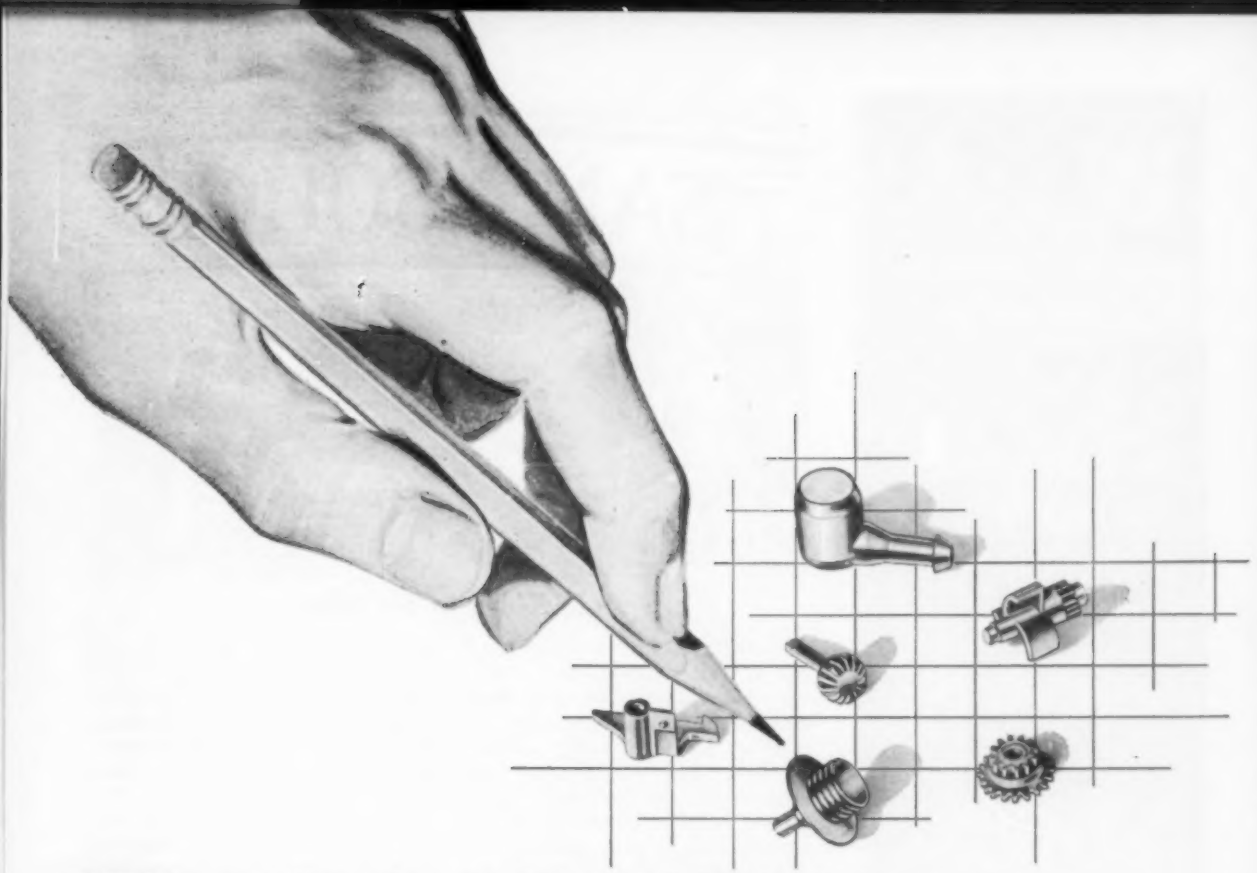

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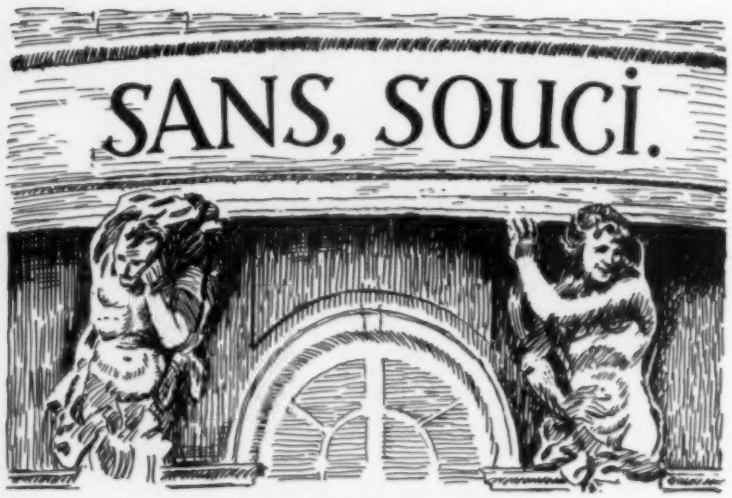

Ad Libbing by the Editor

During my career as a teacher I met and taught, or failed to teach, many hundreds of young men. Some were bright and scholastically outstanding. Some were bright and lazy. Of course there was also the sprinkling of students who were not so bright. Most of these last fellows worked hard and made commendable records. But of all the groups, the most interesting one was that composed of the bright boys who aimed to get the most out of college by having the maximum time available for activities other than scholastic. One of these boys was a young fellow whom I shall call Mike because that was not his real name.

Mike was an extremely affable fellow. He was bright. But he was far more interested in many activities that were definitely not scholastic. In fact, his aim was to "get away with it" in the class room so that he would have more time for bridge, dancing and earthy conviviality. And because he was such an engaging young fellow, he succeeded in reaching his junior year without much difficulty. But there he stubbed his toes.

By the time Mike got into the second term of his junior year things began to catch up on him. He had a complete lack of understanding of the prerequisites that were required for many of the subjects for the junior year. And to make matters worse, he had the notion that he could "talk his way" through the junior year just as he had done in the lower classes. But things did not work out that way. Mike was flunked out of college.

Now Mike wasn't the type of fellow who would waste time crying over spilled milk. And he was not the sore-head type who stands ready to blame everybody but himself for misfortunes. He was a realist with a perpetual smile. Knowing that he could not re-enter college for another year, Mike took it upon himself to get a job as a crew member on a tramp steamer that was scheduled to go around the world.

Various members of the faculty began to receive postal cards from Mike as his plodding tramp steamer stopped at port after port. These postal cards began with the Panama Canal. They included Hong Kong, Singapore, Marseilles, London and many ports in between. And each postal card carried with it a happy message. My associate, Professor J. A. Mease got cards. So did I. Mease and I were the profs who flunked out Mike. And he knew it.

Finally there came the day when Mike the optimist, got back to the campus, took his re-entrance examinations and was reinstated as a student in mechanical engineering.

Mike did do some studying. Extremely careful studying. That is, he was always extremely careful that he didn't study too much. If his passing grade was two per cent higher than required, he considered it poor judgment on his part. To him it reflected a waste of time and effort.

There came a day when a company representative came around to the campus seeking a man to hire for a job in the sales department. He explained in great detail to Professor Fred Larkin, the Head of the Depart-

(Continued on page 337)

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FOR PRODUCT DESIGNERS

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Next time someone says, "Make it small and accurate," reach for your file on *photosensitive glass*.

Using a process called "chemical machining," photosensitive glass now yields intricate and accurate components for both electrical and mechanical applications.

Starting with a Corning special glass, chemical machining makes it possible to achieve an intricacy never before thought possible. And it's all done *without* the need for costly grinding, drilling, cutting or engraving.

Let's take a look at some chemical machining in practice, a good example being this wire brush holder for a tiny airborne digital converter.

Made of glass by a combination of photo, heat and etch processes is this precision brush holder for a digital converter. In background are holders that have been exposed and developed but not yet etched.

As originally designed, this converter had 0.0065″ single wire brush contacts. Brush holders were of a glass fiber reinforced laminate. But, the smallest holes that could be drilled in this laminated material were 0.015″ in diameter. Result? Loose-fitting wires.

Turning to the miniaturization and precision offered by photosensitive glass, designers came up with a brush holder with *rectangular* holes, 0.0075″ x 0.015″.

Two wires (each 0.0065″) are inserted side by side in each hole. Holes are etched through the glass and have a conical cross section. The lip of this cross section serves as a reference point about which the free ends of the brush cantilever.

Spacing of the slots is held to a tolerance of 0.001″ over 1½″, making it possible to position the double brush contacts with close tolerances.

Etched glass also plays a role in assembly, with an alignment plate used to locate the free ends of the brush while fixed ends are cemented.

Behind this *accuracy-by-acid* is some quite ingenious exploiting of differential rates of etching glass. And there's also some interesting use of collimated ultraviolet light and heat.

You can learn a great deal more about photosensitive glass (including other uses) by writing for "Chemical Machining Photosensitive Glass," a reprint of an article that ran in *Materials and Methods*. Free with the coupon.

Viscosity, visibility and versatility

From the production lines of the Precision Scientific Company of Chicago comes this Transformer Oil Oxidation Test Apparatus.

This bit of precise plumbing is a second cousin to another Precision product, the Model "S" Kinematic Viscosity Bath.

Used profusely in both is PYREX brand glass No. 7740. First, there are PYREX brand jars (12″ x 18″) forming the main chambers of the test apparatus. Then you'll find an almost bewildering array of tubes and tubing, some of it quite intricate in shape. And there are also Erlenmeyer flasks and glass umbrellas.

Behind Precision's choice of glass is the need for visibility, plus *accuracy and precision*.

PYREX brand glass No. 7740 handles all these requirements admirably. It's known as the "balanced glass,"—balanced for chemical stability, heat shock and physical knocks.

No. 7740 demonstrates a remarkable reluctance to mix with, or be affected by, what you put *in* or *around* it. Among the usually destructive forces that bother it not at all are most acids and alkalies, as well as steam.

This *not adding to or detracting from* is one reason why No. 7740 is the favorite among those who must protect delicate flavors. That's why, for example, you'll find this glass in coffee makers, both commercial and household varieties.

And PYREX No. 7740 stands up to physical knocks. It takes thermal shocks in its stride, too, having a linear coefficient of expansion of 32.5 x 10^{-7} between 0° and 300° C.

A clear glass, it's available in economical quantities as blown or pressed ware, and in plates, panels, tubing and rod.

Even one-piece molding of fancy shapes has been done with this most popular of all glasses made by Corning.

Can some particularly knotty problem of yours find its answer in this or some other glass by Corning? Good way to start finding out is with our Bulletin B-83, "Properties of Selected Commercial Glassware." It details characteristics of many of the glasses sold under the PYREX, CORNING and VYCOR trademarks.

This basic reference volume is yours for the asking. You can get one quickly by using the coupon.

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"Glass and You," a profusely illustrated volume showing how many businesses and industries use glass profitably.

And there's Bulletin B-84, "Manufacture and Design of Commercial Glassware," a brief summary of design considerations in making glass by various methods; also data on sealing and assembling glass to metal.

Plus an invitation to consult with us via the written word, phone, or wire, on utilization and availability of *glass* as a basic material of design and construction.

With 105 years of experience in glass technology behind us, and with the formulas for some 65,000-odd different glasses on tap, we've acquired quite a bit of useful know-how.

You can make use of it at your convenience. And, if you're in the area, be sure to stop by at The Corning Glass Center. Here you will find both the oldest and the newest uses for glass. We would be glad to send you a preview of what may be seen. Check the coupon.

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PILLOW BLOCK AND BALL ASSEMBLY FOR EVERY TYPE APPLICATION

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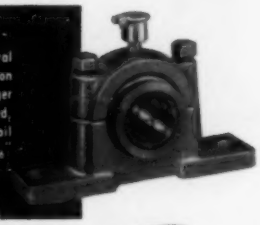
NORMAL DUTY PILLOW BLOCK. A general service pillow block for normal duty on small shafts and for heavier duty on larger shaft sizes. Double lubricated with graphited, phospor bronze bushing in wool packed oil reservoir housing. For shafts $1\frac{1}{2}$" to $3\frac{15}{16}$" inclusive.



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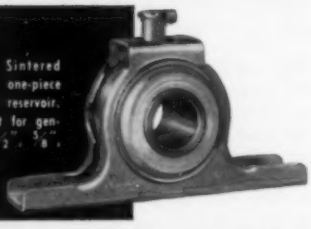

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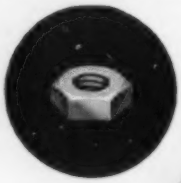

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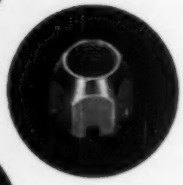

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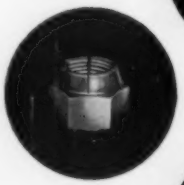

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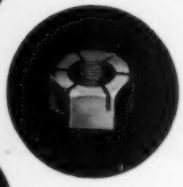
"MARSDEN"



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ment of Mechanical Engineering, exactly the type of man he needed, and the kind of job that was to be filled. He wanted "the smartest man you have. The highest standing scholastically." Professor Larkin was a very shrewd judge of men and an understanding person. He said to this man, "I will send in to you the three best men that I have according to your specifications. After you have interviewed these men and decided that you don't want any of them, I will send you in the man whom I consider to be best equipped to fill the job you have open."

And that is exactly the way it went. The company representative interviewed the three best men in the class, scholastically speaking, and he found them extremely uninteresting.

Professor Larkin then said, "Now I will send you in the man you want. He is not in the top bracket of his class. To the contrary, he is near the other end of the bracket. But he is the man you want."

It was a hot summer's day and Professor Larkin phoned Mike to come to his office for the interview. Mike did, driving down in the fraternity house's jalopy. When Mike came into Professor Larkin's office he was introduced to the personnel man, Larkin then told them to go ahead with their discussion without him as he had to attend a faculty meeting. The discussion went something like this:

"It sure is a hot day," said Mike.

"It certainly is," said the personnel man. "And it sure is a hot job walking up this hill to this office."

"You said it," said Mike. "You know I have a jalopy outside and I think it would be a swell idea if we went down to the tavern and discussed this job proposition in the cool atmosphere of the bar room."

Thus, about ten minutes later, Mike and his companion, who by this time was his guest, were comfortably seated in the beer parlor. By the time they parted, Mike had been offered a fine job in the sales department. After graduation Mike began his job working immediately under the head of the department.

About nine months later Mike's boss was scheduled to give a speech at a trade association meeting. As it turned out, his boss got a bad cold and couldn't deliver his speech. So

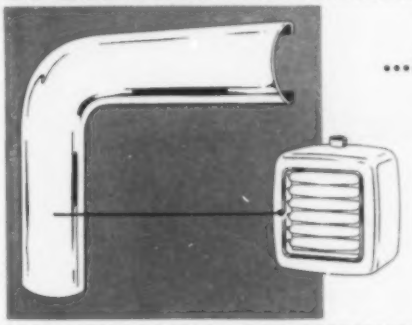
(Continued on page 341)

Custom Tailoring From a

Standard Shape

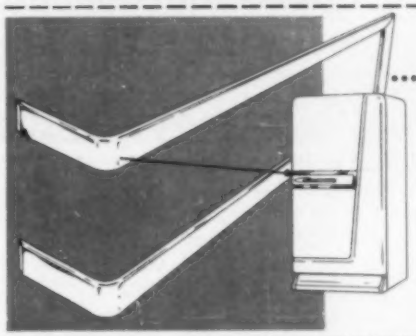
Pyramid Mouldings

Design Clinic



...AT NO TOOL COST

Standard sections *can* be custom tailored to combine *dollar savings* with *individual design.* For this heater, a standard Pyramid shape . . . combined with a standard radius bender . . . provided custom tailored trim . . . at *no tool cost.*



...AT *LITTLE* TOOL COST

As shown by this door panel trim, a simple addition to standard tooling can often custom tailor a standard shape to a specific application. Here an inexpensive bending fixture transformed a standard section into individual panel trim.

WRITE FOR YOUR FREE "PLAN BOOK OF METAL MOULDINGS"

For low cost, custom application . . . check your requirements against Pyramid's hundreds of standard shapes and, in many instances, standard bender fixtures and press dies. Send for Pyramid's "Plan Book" today.

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"FOR MAXIMUM KILL-PROBABILITY"

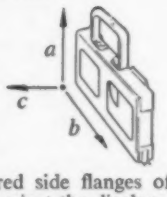
Starfighters' Fire-control Radars Use Barry's NEW Integral* Mounting Systems

In the most advanced airplane of its type ever developed — Lockheed's F-104A Starfighter — Barry's new Integral* Mounting Systems are solving the toughest combination of shock, vibration, and sustained-acceleration problems ever posed by jet aircraft. Literally a "missile with a man in it", the F-104A demands that equipment mounts give superior performance, in less space, and at lighter weight than ever before.

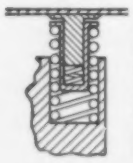
Here's how Barry's Integral* Mounting Systems are meeting this demand in the production models of the Starfighter.

In a space only 12¾ x 5⅜ x 1-13/32" on each side of a 150-pound load . . . a pair of units weighing less than three pounds each . . . provides adequate vibration isolation at 4g sustained acceleration in all radial directions . . . passes all shock-test requirements of this supersonic fighter . . . performs reliably through wide temperature and altitude ranges . . . and provides positive, quick-release attachment to the airframe to satisfy Lockheed's requirements for "plug-in" electronics-system components.

Here's the way this system works.



Helical springs designed to function in their axial direction only are grouped about the load attachment points so as to provide controlled resistance to movement along the *a* and *b* axes. For the *c* axis, resistance is provided by the slightly tapered side flanges of the mounting frame working against the displacement of all the load-carrying springs.



Damping adjustments (see diagram), completely independent of the stiffness of the load-carrying springs, provide design flexibility for obtaining desired natural frequency, transmissibility at resonance, and degree of vibration and shock isolation.

Write for THO-5 containing a full exposition of this All-Angl Integral* Mounting System.

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BARRY B MOUNT

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Integral means . . .

Designed specifically for the environment performance requirements.

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"To Err is Human..."

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President
43 years

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21 years

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21 years

HANS HANSON
Die Room Supervisor
40 years

VINCENT SARACCO
Eng. Asst. to V. P.
15 years

GEORGE NEWBERG
Tool Room Supervisor
32 years

— but when we've made mistakes at Mt. Vernon, it's the customer who benefits

If there lives a man who has never made a mistake—it's because he has never had the courage to try anything new.

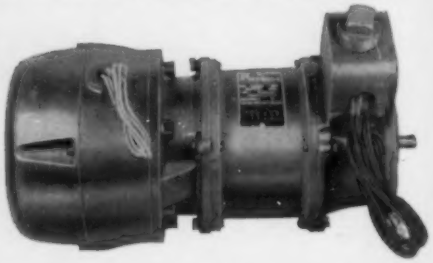
The 6 men pictured here are the men to whom you entrust your work when you hire Mt. Vernon to do it. The total of their experience in die casting adds up to 172 years.

Each of them is exceedingly human—and each of them would be the first to admit that he has made some mistakes. But in doing so, he has learned better ways of giving you ever finer die casting, at ever lower cost to you.

It is these men's perpetual discontent with doing things the accepted way, the "good-enough" way, that has gained for Mt. Vernon the enviable name that we have today. It is because they *have* made some mistakes—and because *you* have profited by them—that the firm which in 1905 started in a modest 2 story building (inset) has grown into this complete and completely modern die casting plant occupying 200,000 square feet.

MT. VERNON
DIE CASTING CORP.
STAMFORD, CONNECTICUT

Where Special Requirements Dictate Motor Construction



This peculiarly shaped motor opens and closes pipe line valves without fail in all types of weather. It is a special weather-proof torque motor designed by **Peerless Electric** in cooperation with a valve manufacturer and is equipped with an electrically operated brake. The motor shown here measures approximately 10" in diameter and 31" in length but **Peerless** can produce it in many other sizes.

The outstanding product performance attained with this motor is a result of teamwork engineering — **Peerless** — **OEM** cooperation. Submit your next motor problem to **Peerless.** We'll work with you to design or select the one motor that operates your product best.

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ELECTRIC MOTOR DIVISION

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Sans, Souci .....continued

he called upon Mike to deliver the speech which had been written. Mike's protests were of no avail. The boss told him that all he would have to do would be to read the speech and possibly answer a few questions. That last was the part that Mike didn't like because he didn't know enough about the business to be able to answer questions intelligently. At least, so he thought.

On his way to the meeting in the distant city, Mike pondered a great deal as to what he would do when the question time came. Before Mike was introduced to the audience he had found his solution. He delivered his speech and the chairman of the meeting then asked for questions from the floor. The first question was an excellent one, at least for Mike's purposes. The question was, "What are the relative merits of anthracite versus bituminous coal?" This question was meat and gravy for Mike. His answer began with, "You have presented what is perhaps the most vexing problem of the industry. There is much to be said concerning this matter. . . ." And from there on Mike expounded for almost a half hour on the relative merits of anthracite versus bituminous, always making sure that his innocuous statements would be acceptable to all in the audience. And by the time Mike stopped his "line of gab," it was time to adjourn. And that's what happened.

Years later I was talking to Mike about this incident and he grinningly said to me, "The way I figured it, all I had to do in answering this first question was to talk and talk until time was up. Then there would be no time for a second question. And also, my long winded answer to the first question might give the people an idea that I really knew something about the subject, which I didn't."

It was only a few years later that Mike became General Manager of the company, which goes to show that it takes more than merely scholastic knowledge or professional know-how to achieve business success. It will always be true that the congenial man who is well stocked with humor, whose company is enjoyed by those he meets, will be heartily welcome, whereas the "sour puss" who is "oh so right," receives scant attention, gets little credit and thereby fails to progress. —G. F. N.

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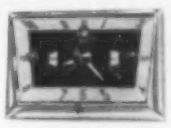

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DON'T COMPROMISE ON DESIGN FREEDOM!

Now, your equipment can be lighter, stronger, tougher—made with economical new Lukens "T-1" steel!

■ The unique qualities of this amazing new material offer you greater design freedom than ever before in a high-strength steel! It has unusual resistance to impact, abrasion and atmospheric corrosion. It's tough and *stays* tough at low temperatures. And it combines these qualities with *triple* the yield strength of ordinary carbon steel! These advantages are changing the design of equipment and machinery in a growing number of industries.

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No wonder this remarkable steel is finding its way into so many new plans. And Lukens "T-1" steel can be had in the widest range of plate sizes available anywhere!

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Whatever your plans—now's the time to change to . . .

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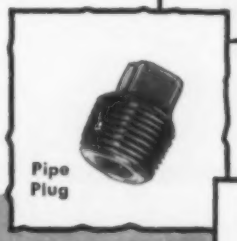

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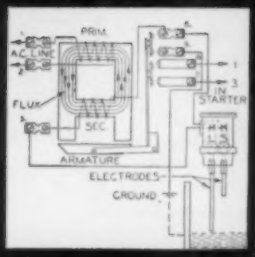
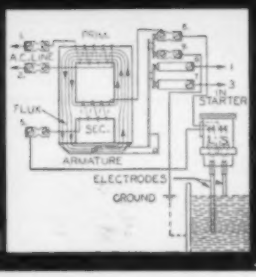
LIQUID LEVEL CONTROL
with the
B/W RELAY





Type LH Relay
for
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POSITIVE AND DEPENDABLE

The B/W system of liquid level control consists of a transformer type induction relay and a holder for one or two electrodes, depending on the desired operation and the type of relay used. The relay incorporates a primary or line voltage coil connected to a permanent source of alternating current, and a secondary or electrode circuit coil connected to the electrodes immersed in the liquid being controlled. Energizing the primary coil causes an induced voltage in the secondary coil; thus the secondary coil is never connected to the power line.

LIQUID IS ELECTRICAL CONDUCTOR

The liquid itself is the electrical conductor that completes the secondary circuit. When this secondary circuit is completed, by the liquid contacting both electrodes, the magnetic attraction set up in the legs of the relay core causes the armature to close, and open or close the load contacts. A built-in holding circuit maintains this contact until a predetermined fall in liquid level breaks the circuit. By adjusting the electrode settings, the range of operation can be controlled.

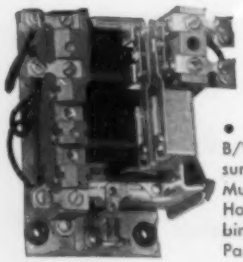
FOR PUMP UP and PUMP DOWN APPLICATIONS, SIGNALS and ALARMS

B/W relays are designed for either pump up or pump down operation. In addition, by using a single electrode they are well suited for signal and alarm applications.

NO MOVING PARTS

The complete absence of moving parts in the liquid insures long and trouble-free performance. Because of the very low current in the secondary circuit these relays are ideal for many switching jobs outside of the liquid level field.

Consult our engineering department on any special control applications.



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PIPE PLUGS These vital items are produced economically and accurately at ELCO by the cold-heading roll-threading method. The leak-proof "Dry-Seal" design is an ELCO specialty. Modified designs are engineered and produced to order. Second operation work is available, such as vent holes, safety wire holes, etc. ELCO Pipe Plugs are stocked in steel, stainless steel, aluminum, bronze, and brass. *Write for our stock list.*

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MACHINE SCREWS	STOVE BOLTS
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PHILLIPS AND SEMS SCREWS	SPECIAL SCREWS

COLD HEADED PRODUCTS

WE ALSO SPECIALIZE IN MAKING ANY OF OUR PRODUCTS OF THE FOLLOWING MATERIALS

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1958 BROADWAY • ROCKFORD, ILLINOIS

ABSTRACTS

Stress-Hardness Relation

An attempt to correlate the state of stress in a material with its surface hardness shows some promise as a field tool for stress analysis of structures in service. Spherical hardness tests on normalized mild steel showed hardness to be a precisely linear function of tensile stress; relation between hardness and compressive stress was not as well defined. The author attempted to establish a verifiable equation for ball loading based on Herz-Huber contact stress theory, but unsuccessfully; however, should continued tests clearly establish linearity of tensile stress with hardness, use of a calibration curve and a suitable hardness tester (as yet undeveloped) may permit determination of surface stresses, both residual and applied, on structures in the field. The effects of a biaxial state of stress on hardness, however, will require analysis before such a method can prove effective.

Abstracted from "The Stress-Hardness Relation" by A. Dervishyan, University of California at Los Angeles, *ASTM Bulletin*, July 1956.

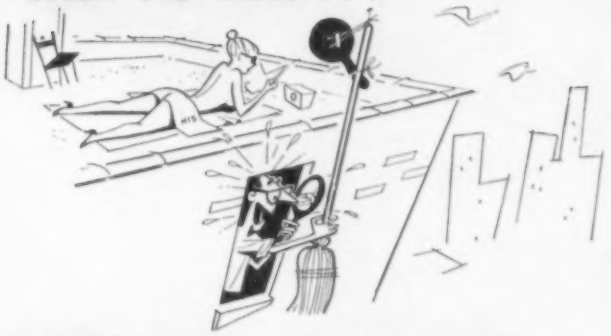
Testing Dynamically Loaded Bearings—I

Until recent times, bearing designs for all types of machinery were based upon tests conducted in steady-load machines, together with service experience and hydrodynamic calculations.

Steady load or "statically loaded" bearing test machines have already been reviewed in the available literature. Load-capacity values from steady-load tests were at first found satisfactory in designing dynamically loaded bearings. But with increasing loads and speeds in engines and other reciprocating machinery, it became evident that fatigue failures would be a limiting factor in the life of dynamically loaded bearings. Such failures could not be predicted from static tests. For this reason, among others, it was necessary to devise machines suitable for endurance testing with dynamic

(Continued from page 349)

WHY DO THIS...



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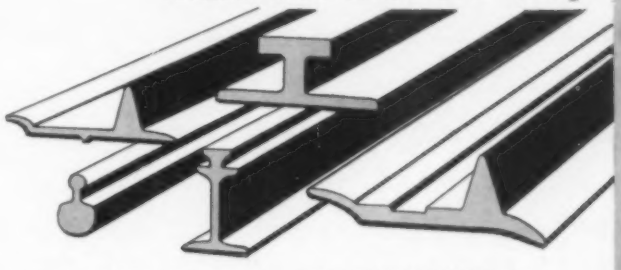

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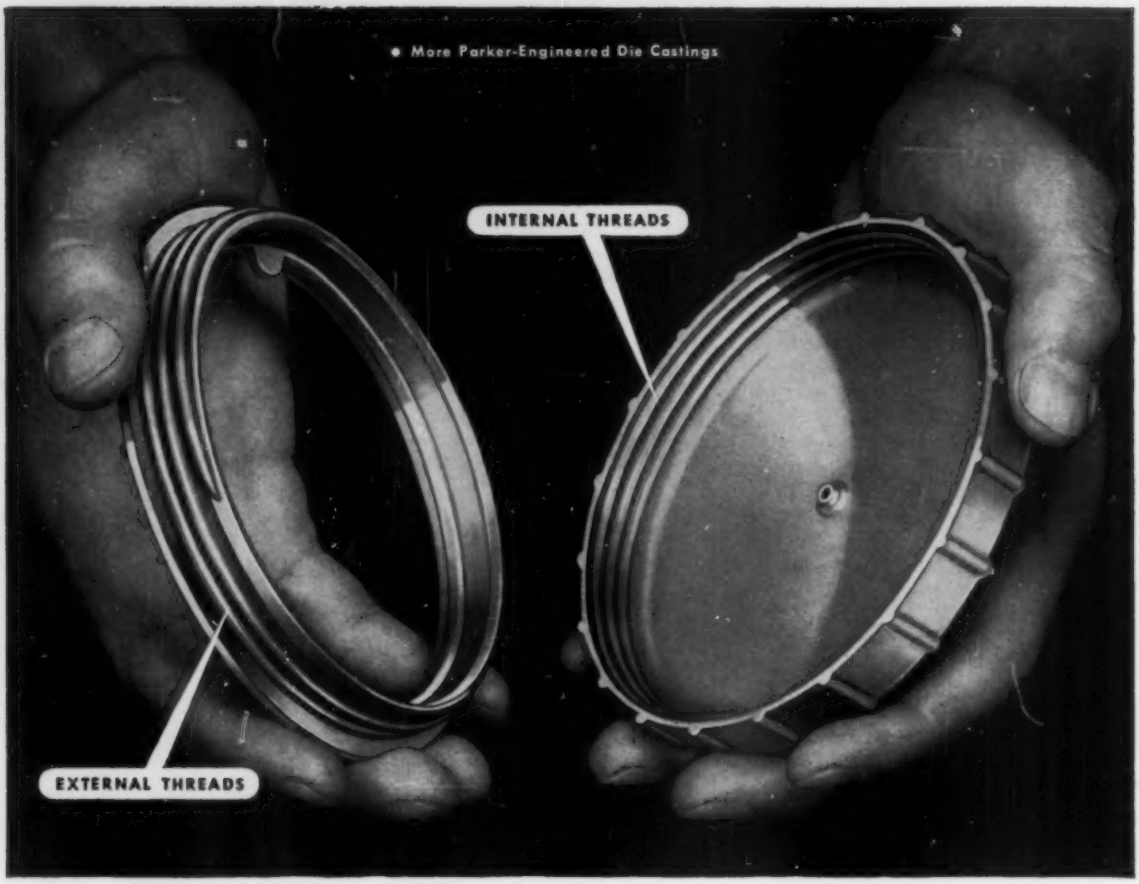

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These two mating parts, including the threads, are cast simultaneously in the same die. The result—three savings:

1—One die instead of two *saves die cost*

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Shown here is a new semi-automatic hold-down device for securing highway trailers to flat cars in piggyback service. Developed by American Car and Foundry Division of ACF Industries in cooperation with the Pennsylvania Railroad and Rail-Trailer Company, this retractable trailer hitch moves up to brace the trailer in place, folds down flat to give clearance during loading.

ACF uses high-strength Mayari R plates to build this hitch, which is substantially stronger under impact than earlier types of braces. One man with a power tool can now secure a trailer in 2½ minutes, instead of the usual three-man crew requiring 5 minutes.

Because Mayari R has a higher yield point than carbon steels, it provides greater strength than carbon steel of the same section. Or it can be used in lighter sections to reduce deadweight. It has superior resistance to corrosion and abrasion, and good impact properties. It can be worked and welded as readily as other steels.

Catalog 353 contains detailed technical information about Mayari R, along with many interesting photographs and case histories covering a wide variety of applications. A copy will be sent you promptly upon request.

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Mayari R...High-Strength, Corrosion-Resisting Steel

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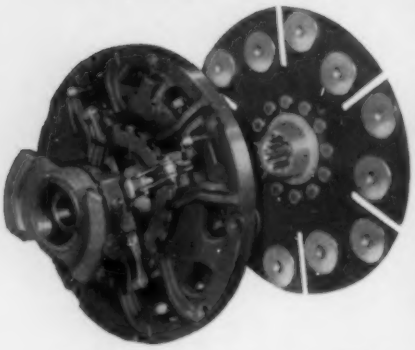

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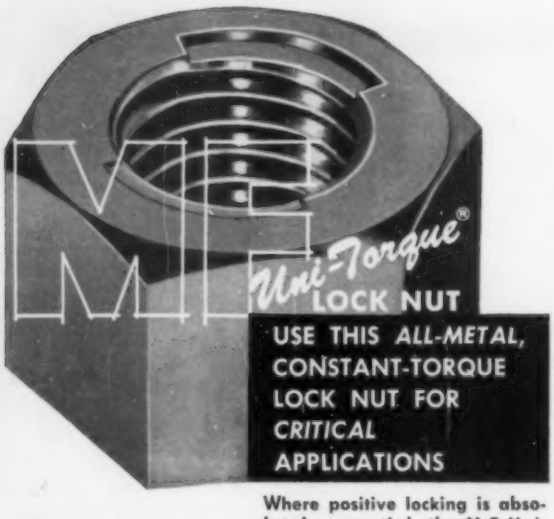

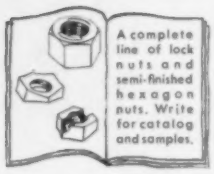

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loading.

A parallel change took place in the hydrodynamic theory of lubrication. Efforts were made by several investigators to develop a theory of dynamically loaded oil films by which film thickness and other elements of performance could be calculated. These efforts met with difficulty owing to our limited knowledge of cavitation and side leakage. It was found necessary to supplement theoretical deductions by extensive experimentation. That situation accounts for the design of some research machines.

The machines described in this paper have first been listed chronologically in two groups, "endurance machines" and "other research machines." No sharp line of demarcation is possible, since machines designed for other purposes could later be used for endurance testing. The machines are then classified by the type of loading employed, and finally described individually.

Abstracted from "Testing Dynamically Loaded Bearings—I," by M. D. Hersey and R. B. Snapp, presented at ASME ASLE Lubrication Conference, Oct. 8-10, 1956. ASME, 29 W. 39th St., New York 18, N. Y.

Compressive and Torsional Buckling of Thin-Wall Cylinders in Yield Region

Based on assumptions which have led to the best agreement between theory and test data on inelastic buckling of flat plates, a general set of equilibrium differential equations for the plastic buckling of cylinders has been derived. These equations have been used to obtain solutions for the compressive and torsional buckling of long cylinders in the yield region.

Test data are presented which indicate satisfactory agreement with the theoretical plasticity-reduction factors in most cases. Where a difference in results exists, test data are in substantially better agreement with the octahedral-shear law to transform axial stress-strain data to shear stress-strain data.

Abstracted from "Compressive and Torsional Buckling of Thin Wall Cylinders in Yield Region," by George Gerard, New York University, National Advisory Committee for Aeronautics Technical Note 3726, Aug 1956.

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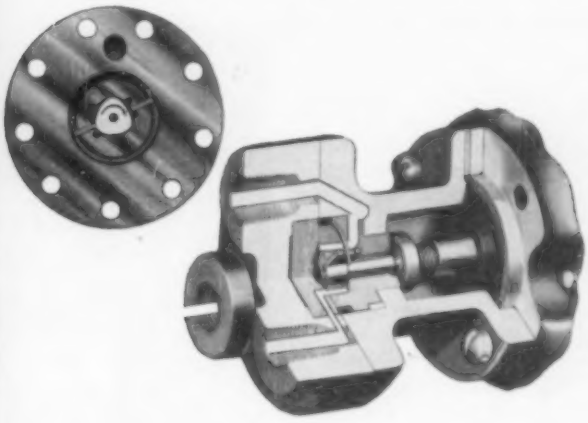

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The rotation of the rotor draws the fluid in through two passages, filling the cavities formed by the three lobes of the rotor. This fluid is sealed within these small cavities until it is forced through the two outlet holes by the floating blades. The flow may be kept uniformly divided through two outlet ports, or may be combined internally for passage through a single port.

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Sales appeal of an Electronaire filter is permanence . . . and washability. Never needs replacing; cleans easily in water.

The retaining grilles won't rust . . . can't ever loosen . . . yet allow free passage of air and water. That's because they are shaped from remarkably versatile Penmetal expanded aluminum.

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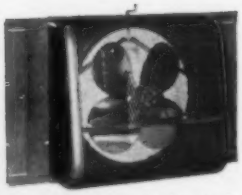
Railroad Car Air Filter (Farr Company, Los Angeles, Calif.)



Fan Enclosure (Atlas Tool & Manufacturing Company, St. Louis, Mo.)

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Remember the tale of the three stone-cutters?

One day, an old scholar stopped to watch three stone-cutters at their work.

All three were cutting stone into blocks for a new cathedral. The old man went up to each of them in turn and asked the same question.

He asked, "What are you doing?"

The first one replied, "I'm cutting stone, of course. That's plain to see."

The second stone-cutter answered, "What am I doing? I'm earning five florins a day."

But the third man, though he, like the other two, was cutting stone, made this reply:

"I'm building a cathedral," he said.

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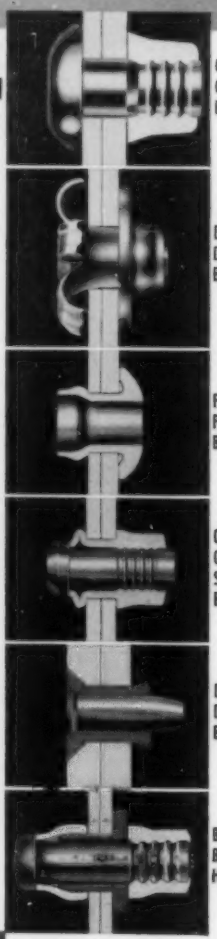

CL— Commercial Huckbolt

DR— Daisy Blind Rivet

PT— Pull-Thru Blind Rivet

OS— Oversize Structural Blind Rivet

DEUTSCH— Drive-Pin Blind Rivet

BL— Blind Huckbolt

HUCK MANUFACTURING COMPANY

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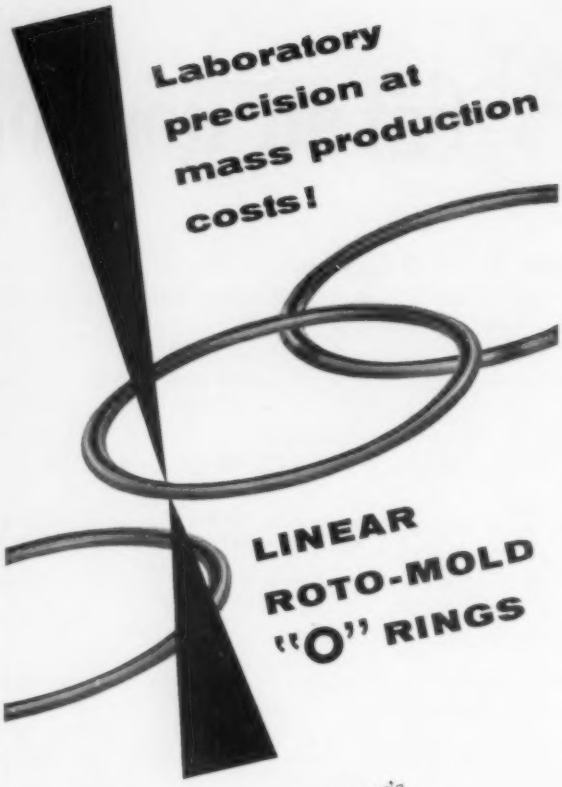

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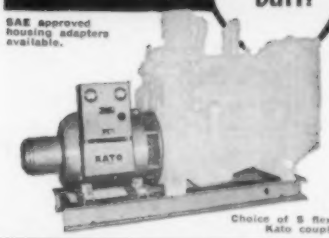

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NEW BOOKS

American Standard 20 Deg. Involute Fine-Pitch System

AGMA 273.04, ASA B6.7-1956. 8½ x 11 *in.*, 23 *pp. Published by American Society of Mechanical Engineers, 29 W. 39 St., New York 18, N. Y.* $1.50.

The spur gear portion of this standard closely follows the American Standard for Spur Gear Tooth Form (ASA B6.1-1932), with a slight increase in whole depth to allow for the greater proportional clearance necessary in fine-pitch gears. It is generally known that fine-pitch gears must have greater clearances than coarse-pitch gears.

The fine-pitch series includes gears of 20-diametral pitch and finer having a 20-deg pressure angle. Tables, data sheets, charts, and examples concerning pinion enlargements are included. It is recommended that the use of pinions having less than 10 teeth be avoided. In order to discourage their use, pinions of 7, 8, and 9 teeth are treated separately.

The 20-deg pressure angle is the most satisfactory selection because a smaller pressure angle would require a greater number of diameter modifications, and a larger pressure angle would make point widths of generating tools too narrow. Also a larger pressure angle would require closer tolerances on center distance for fine-pitch gears to be assembled without backlash.

Elevated-Temperature Properties of Coppers and Copper-Base Alloys

8½ x 11 *in.*, heavy paper cover, 248 *pp. Published by American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.*, $5.50.

Another of a current series of reports prepared under the auspices of the Data and Publications Panel of the ASTM-ASME Joint Committee on the Effect of Temperature on the Properties of Metals, this report is

(Continued on page 357)

HYSOL

Plastic Tooling Materials . . .

• *Cut Costs*

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in these applications

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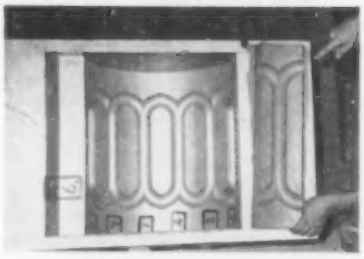

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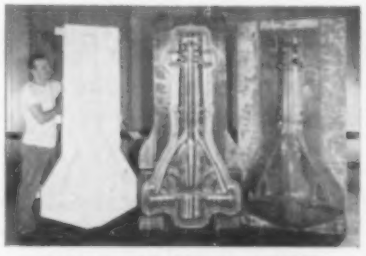
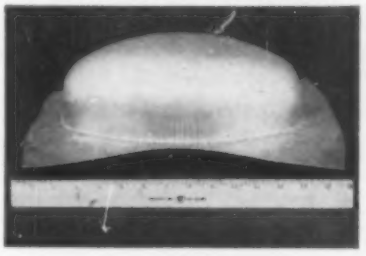


• DIE FORMED PART •



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Corrosion is a real threat to aluminum, especially to the higher strength alloys. It can be controlled by using a chemical surface treatment, with results as dramatically effective as those shown in the illustrations at the right.

The corrosion protection is effected by Bonderite 710 or 720, applied by spray, immersion, or brush-on methods. A thin, iridescent coating, light to golden brown depending on the alloy treated, covers all surfaces of the aluminum and protects it against corrosion.

The coating produced by Bonderite is integral with the metal itself. It is flexible and can withstand moderate draws without difficulty. Arc and spot welding fabrication methods need not be changed, because the coating conducts electricity. It has good resistance to bimetallic and galvanic corrosion. Sheets, castings, forgings, extruded and rolled structural forms may be treated.

Bonderite 710 and 720 solutions are sludgeless, easily controlled, uniform in results.

These treatments may be used to increase the durability of paint finishes with equally outstanding effectiveness.

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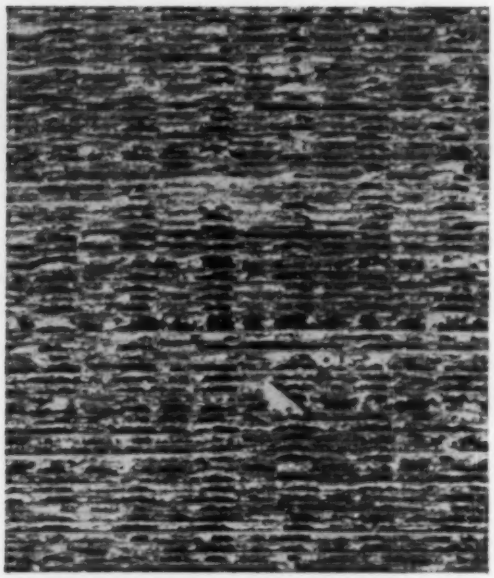
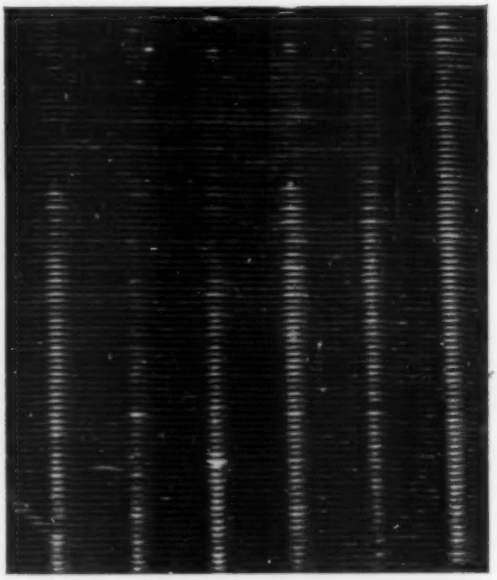


UNTREATED—Unretouched photo of section of aluminum heat exchanger after 1150 hours in salt spray. Note corrosion.



BONDERITE-TREATED—Unretouched photo of section of identical aluminum heat exchanger after 1150 hours in salt spray. Note absence of corrosion.

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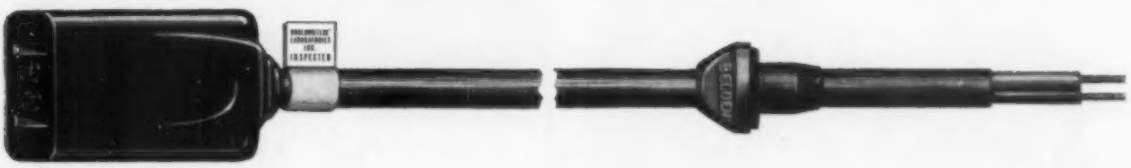

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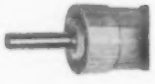
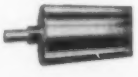


Stainless steel rolls



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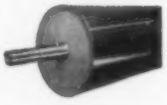

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primarily a graphical summary of the elevated temperature data for coppers and copper-base alloys. Data for the coppers are limited to the wrought materials, while the data for the alloys apply to cast and wrought materials.

Graphical data includes modulus of elasticity, tensile strength, yield strength (0.5 per cent extension and 0.2 per cent offset) reduction of area, elongation, stress for creep rates of 0.000001, 0.00001, and 0.0001 per cent per hour and stresses for rupture in 100, 1000, 10,000 and 100,000 hr.

Included in the appendix are data sheets giving the original data for drawing curves. Also included are data sheets giving insufficient information for plotting or of such a nature as not to justify plotting, but meriting inclusion on the basis of contributing to the limited information available on many of the coppers and copper-base alloys. The data sheets also give chemical composition, shape, sizes and processing information.

Space Requirements of the Seated Operator

WILFRED TAYLOR DEMPSTER, *University of Michigan*, 8¼ x 10¼, 254 pp, PB121053. *Available from Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C.* $3.50.

Following is an abstract of this study printed on page iii of the text:

"The structure of the limb joints and the range and type of their motions were studied on cadaver material, with supplementary work on living subjects, in order to clarify geometric, kinematic and engineering aspects of the limb mechanism. Plans for the construction of manikin joints which showed normal ranges of limb movement were developed from this information.

"Specifications were also worked out for drafting board manikins which show correct limb ranges for seated postures. Subjects comparable to the model physique of Air Force flying personnel and highly selected small samples of muscular, thin, and rotund builds supplied information on the range of possible hand and foot movements which was consistent with the seated posture. Maximum dimen-

(Continued on page 361)

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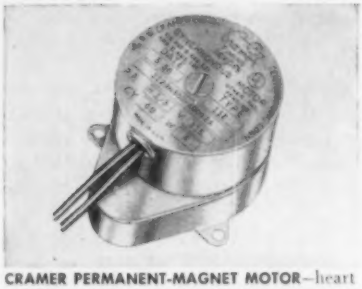
Specifying one of the many standard units offered saves you and your customers time, money



CRAMER PERMANENT-MAGNET MOTOR—heart of Cramer a-c timers. Available separately. Features fast start, truly synchronous operation, no coasting. *STOCKED* in many speeds, right or left rotation. Various output shafts. Torque: 30 in-oz at 1 rpm. Bulletin PB-110A.

Several distinct advantages accrue when you design for a standard timer—as against making a special timer for your specific job:

Cost is lower because no engineering or tooling charges are encountered. Service is quicker and easier. Replacement is simplified. Complete descriptive information and operating instructions are in print.

STOCK TIMERS FOR QUICK DELIVERY. But probably the most important single reason for sticking to standards is ready availability. Quantities of the exact type, range and rating can usually be obtained immediately from manufacturer's stock for prototype or test purposes. Production quantities can be supplied with minimum lead time because design has been completed, parts inventories established and assembly techniques perfected.

EXTREME VARIETY AVAILABLE. Leading timer manufacturers offer extremely wide lines of standard interval timers, time delay relays, cycling timers and time totalizers. In addition, a wide selection is offered within these groups. You can, for instance, pick a standard interval, cycling or delay timer to optimize almost any characteristic needed for your design; cost, mounting, accuracy, actuating means, and degree of adjustability. Each of these sub-categories in turn provides various time ranges, control arrangements and voltage-frequency combinations.

MINOR CHANGES EASY. In the event you can not find a stock or catalogued timer to meet your exact needs, discuss your problem with a full-line timer manufacturer. He will frequently be able to modify a similar unit to your specifications with only minor changes, thus saving you the costs of engineering and lengthy testing.

Only rarely will you have to specify a completely new design. And then your best approach is to talk it over with the specialists in the field of time control.

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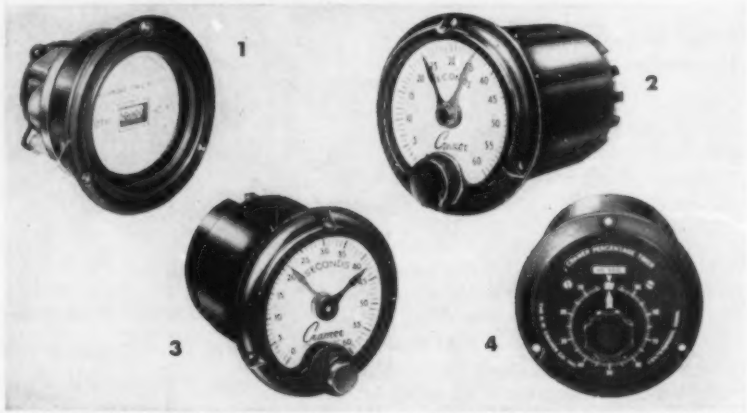
A FEW STOCK TIMERS FROM THE BROAD CRAMER LINE



1. TYPE 631E TIME TOTALIZER. Registers elapsed time on 5-digit drum-type counter. *STOCKED* in total ranges of 9999.9 and 99999 hours at 115V, 60 cps. Also 9999.9 hours at 220V, 60 cps. Other available (including resettable) types count 1/10 seconds, seconds, 1/100 and 1/10 minutes, minutes, 1/10 hours and hours. Bulletin PB-610.

2. NEW TYPE 412 TIME DELAY RELAY. Introduces timed delay between operation of control circuit and load circuit. *STOCKED* in full-scale ranges of 6, 15, 30, 60, 120 seconds; 5, 15, 30, 60 minutes; 5, 12, 24 hours at 115V, 60 cps. Also 15, 60 seconds; 5, 15, 60 minutes at 220V, 60 cps. Bulletin PB-311.

3. NEW TYPE 241 AUTOMATIC RESET INTERVAL TIMER. Provides pushbutton start, automatic and immediate reset for electrically operated equipment. *STOCKED* in full-scale ranges of 6, 15, 30, 60, 120 seconds; 5, 15, 30, 60 minutes; 5, 12, 24 hours at 115V, 60 cps. Also 60 seconds; 5, 15, 60 minutes at 220V, 60 cps. Bulletin PB-241.

4. TYPE 610 PERCENTAGE TIMER. Makes (or breaks) electrical circuit for adjustable percentage of a fixed time period. Calibrated in steps of 1% from 4 through 96. 100% setting provided. Snap action switch. *STOCKED* in ranges of 15, 30, 60 seconds; 5 minutes at 115V, 60 cps. 15, 30, 60 seconds at 220V, 60 cps. Bulletin PB-510A.

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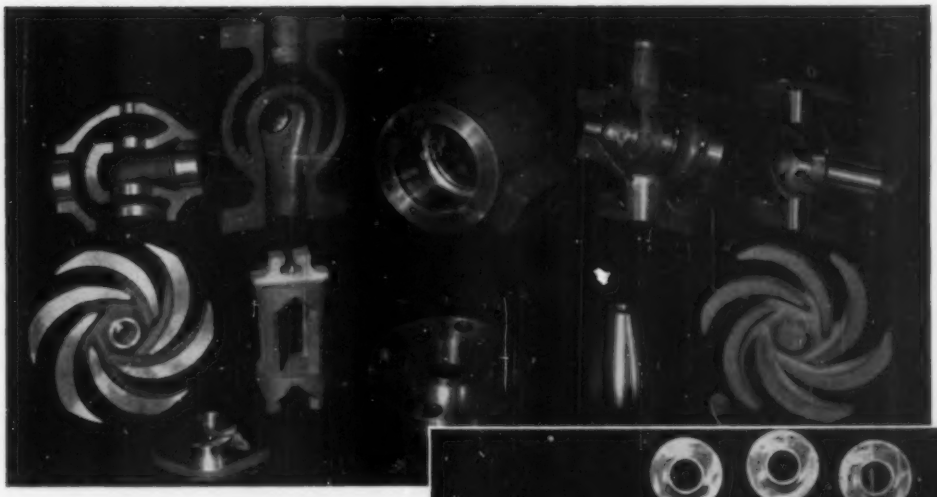

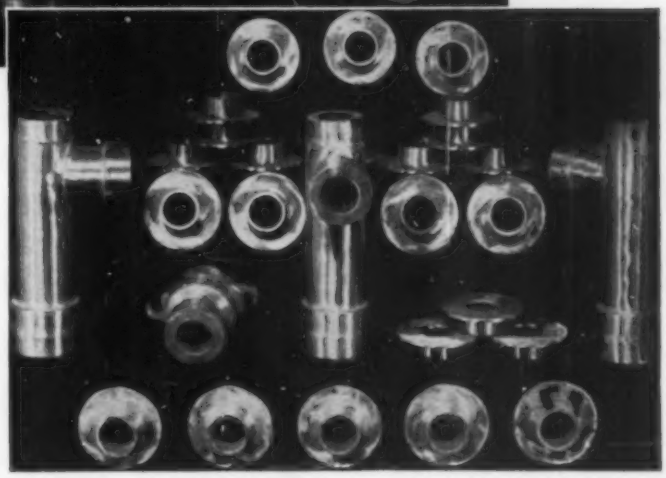

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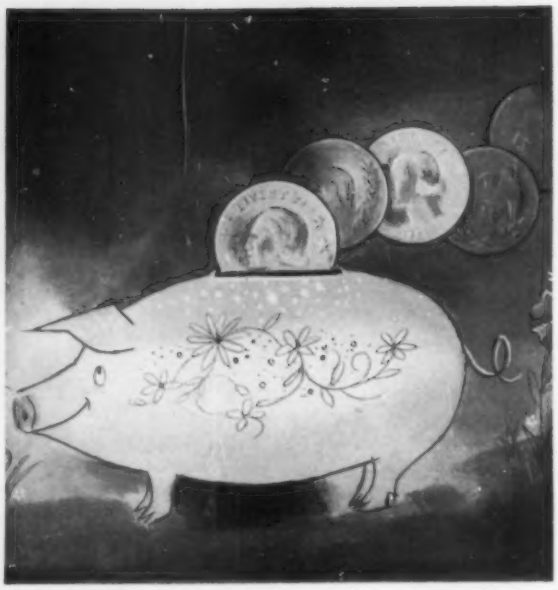

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sions of the work space for seated individuals were determined; a study of the kinematic factors involved permitted an evaluation of the potential utility of different regions within reach."

"Eight cadavers were dismembered to provide data on such physical constants as mass of parts, segment centers of gravity, density and moments of inertia. This work was supplemented by data on the distribution of body bulk in the living subjects studied. Applications of the above information to analyses of horizontal push and pull forces in terms of couples permitted an evaluation of the effectiveness of body mass, leverages and support areas."

Significance of ASTM Tests for Petroleum Products

134 pp, 6 x 9 in., paper-bound. Published by American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa., $2.50.

This book outlines the significance of the various ASTM methods of test related to petroleum products. It calls attention to their limitations. It has been prepared for petroleum executives, scientists, engineers, laboratory technicians, and those concerned with the properties of petroleum products. The book is designed to help them acquire a general idea of the various methods of test and to understand performance characteristics of specific products and the significance of the properties of petroleum products in relation to one another. The language has been kept relatively free of technical terms. Each chapter discusses a particular property or characteristic, covering the importance of sampling, selection of test apparatus, methods of test and significance.

Cams

HAROLD A. ROTHBART, *6 x 9 in., 350 pp. Published by John Wiley & Sons, 440 Fourth Ave., New York 16, N. Y. $9.50.*

This book is written primarily for the designer concerned with creating a mathematical function, motion, mechanism, machine or mechanical

(Continued on page 363)

HOW TO

CONTROL MORE THAN 7,000 functions IN THIS CONFINED AREA

with 3 dimensional

CAMS

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$$z = f(xy)$$

where z is the output of the 3 D cam; *x* and *y* are the two known variables.

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MACHINE TOOL—Automation Functions Repetitive Production, Feed Back Functions, etc.

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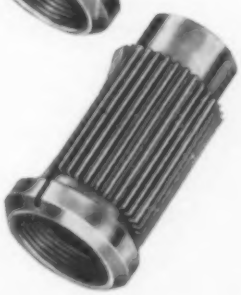

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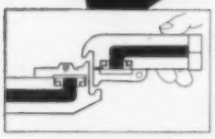
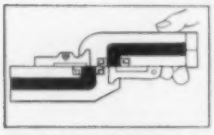
HOSE COUPLER

with NEW LAPPED STEEL SEALS

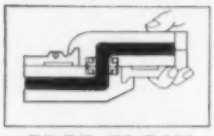
MODEL H-730



HOOK UP



PUSH-CLICK!



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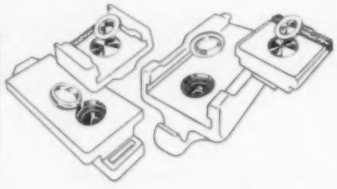
The Model H-730 Coupler now has identical HARDENED steel seals in each half. These interchangeable lapped steel seals are highly resistant to abrasion and nicking. Their durable quality assures a tighter, more positive, leak-proof, free-sliding seal . . . long-lasting, trouble-free.



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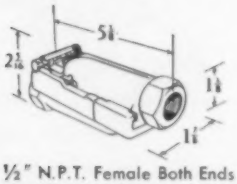
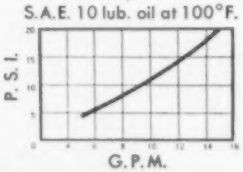
Unusual features are the high flow rating and relatively little pressure loss (see chart). Anodized aluminum die castings make this unit strong, corrosion resistant, light weight and dependable.



½" N.P.T. Female Both Ends

Pressure Drop vs. Oil Flow
S.A.E. 10 lub. oil at 100°F.



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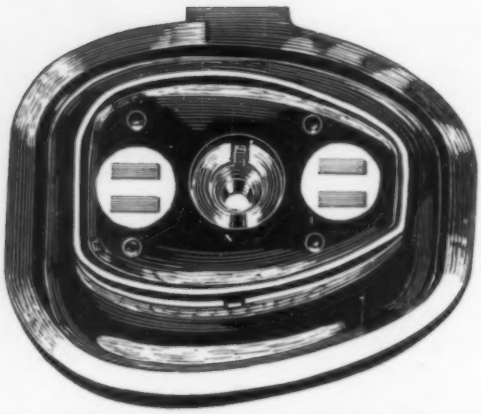

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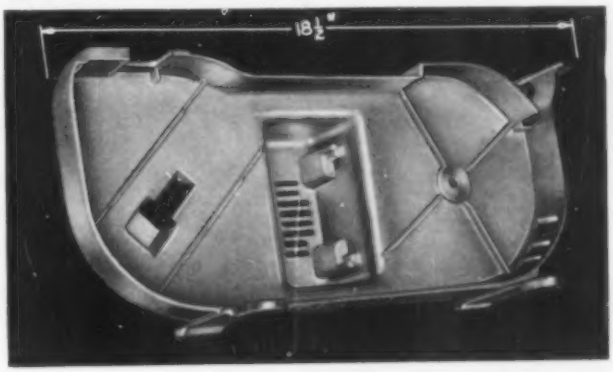
computer. The cam mechanism most easily fulfills many of their requirements. The book may also be of value to mechanical engineering students and instructors.

The investigation of this broad subject of cams required both theoretical and practical excursions into: (1) kinematics, which considers the relative motions of constrained, rigid members; (2) dynamics, which investigates the masses, accelerations, and elasticities of the members; and (3) machine design, which resolves construction and proportion of parts and considers fabrication accuracy.

Besides the diversified cam applications, the presentation of the advanced chapters is aimed toward the expanding field of high-speed machinery. In this category, vibrations play an essential part. To date, the subject of cams was regarded only as part of the study of kinematics, and the following relevant points were not included: (1) the shape of the acceleration curve, which provides data on vibrations, noise, and wear; (2) the flexibility and backlash that exist in most systems; and (3) the accuracy of cam profile in terms of its effect on the performance of the mechanism. These points are pertinent to the study of high-speed operation in which the designer can no longer ignore the necessity of more sophisticated mathematical study, related, of course, to the practical phases of the problems. However, mathematical treatment is kept to a minimum, only that significant to design being presented. Chapters dealing with "Polydyne Cams" and "Dynamics of High-Speed Cam Systems" are of such fundamental nature that the mathematics may be applied to any complex mechanism, cams included. For these chapters the reader should have an understanding of basic vibration theory.

In the later chapters a discussion of profile accuracy and errors is offered. A surface may appear smooth to the eye and yet have poor dynamic properties, and only infrequently does the actual cam agree with the theoretical one. Poor manufacturing techniques can seriously impede the functional ability of a mechanism or machine. Accuracy of manufacturing is discussed together with the methods utilized to achieve this precision as determined by experience and the availability of equipment.



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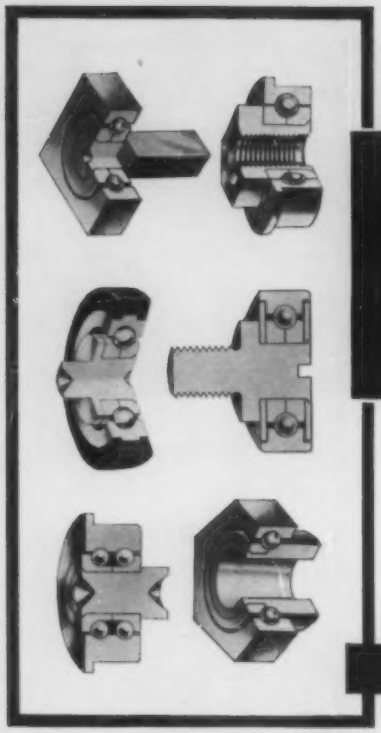

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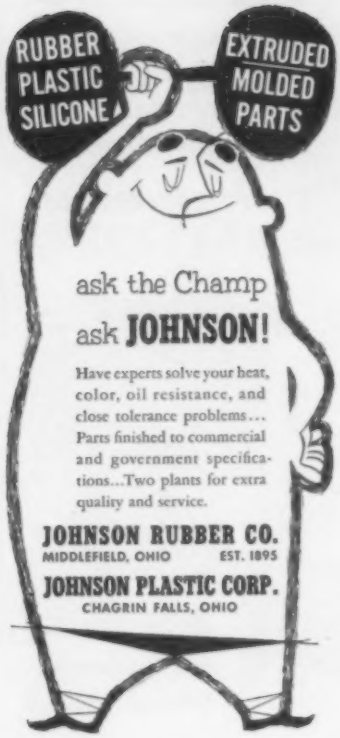

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OUR READERS SAY . . . . . .

Letters should be addressed to the Editor, *Product Engineering*, 330 W. 42 St., New York 36, N. Y.

Job Openings vs. Graduates

To the Editor:

It seems that Mr. Cooper in his article, "Simple Suggestions Concerning the Shortage of Engineers" (Oct. 1956 issue), has, like many others, accepted at face value the statement that there is a shortage of engineers. Actual facts seem to indicate otherwise.

The repeated cry of "shortage" seems to be based on the statistical comparison of "Job Openings" and "Engineering Graduates". Not considered is the vast reservoir of engineers who are already available, a large percentage of whom are not now engaged in the primary field of engineering.

In fact, according to *Research & Engineering*, if only 60 per cent of the engineering graduates of the past 20 years were still working as engineers, we would have an actual surplus of technical personnel. Dan Hendricks, president of the Seattle Professional Engineering Employees Assn., feels that even this figure is conservative. He suggests that if the currently employed engineers spent only 60 per cent of their time at work requiring education beyond the sophomore level, there would be at least 100,000 engineers looking for jobs.

Normally, one would expect an engineer—a man who not only has to have superior brain power, but one who has to spend years in intensive study before he can even start to to earn a living—to receive an income higher than that received by skilled and semi-skilled labor. Yet look at the actual facts. . .

Locally, plumbers, electricians and stone masons receive salaries equal to or more that that offered to engineers—even engineers with several years experience. Auto and real estate salesmen are offered incomes in excess

(Continued on page 367)

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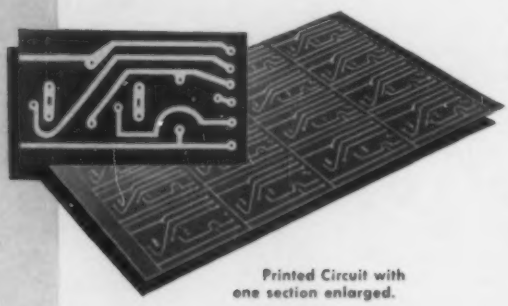

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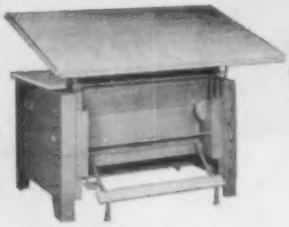

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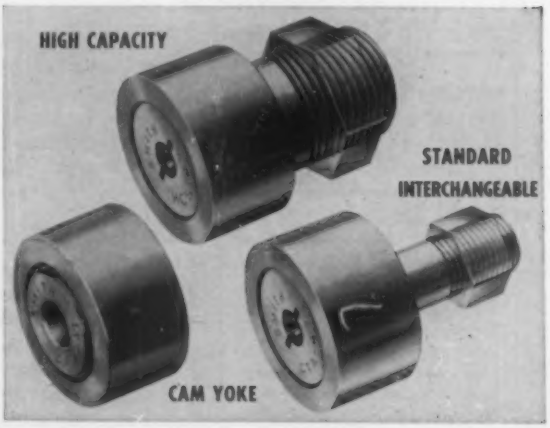

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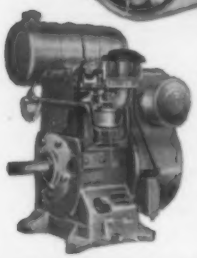

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12.9 H.P. 2-cylinder opposed . . . 4-cycle. Gasoline-powered.

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Onan engines are compact in all dimensions, light in weight, smooth running and easy starting. They deliver full rated power even under a variety of adverse conditions.

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Two-cylinder, opposed. 15 H.P. at 2300 R.P.M. 4-cycle. Solid injection, full Diesel. Electric starting. 12-volt generator. Full pressure lubrication.

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of the salaries offered to high level engineering help. No wonder engineers enter other fields.

Actually, the cries of "engineering shortage" seem to come from several well-defined groups: (a) the Federal government, the lowest paying of all employers of engineers; (b) industry, who, although their files may be literally swamped with applications for engineering positions, find that relatively few of the applicants are willing to accept the salaries offered; (c) educators who, removed from a close view of the situation, seem to go along with government and industry and, in addition, are guided primarily by graduates vs. job openings analysis charts.

The sad fact is that engineering, although well-paid compared, say, to teaching, is actually a low-pay field when compared to the incomes offered skilled and semi-skilled workers in fields where strong union contracts exist or when compared to the incomes offered sales personnel.

LOUIS E. GARNER, JR.
Silver Spring, Md.

Ed—In some instances your statements might be misinterpreted. It would necessitate considerable explanation to clinch the statement comparing the salaries of plumbers to those of engineers. And the same applies to the other comparisons. When you start making comparisons there are so many explanations on both sides, plus and minus, that almost every comparison is valid.

However, your statement that it is in error to base our conclusions on engineering graduates and job openings is valid. And likewise, your statement that engineering is actually a low paid field when compared to the income of our skilled and semi-skilled workers in fields where strong union contracts exist. Money makes the mare go, and the quickest way of overcoming the shortage is to offer adequate engineering salaries.

Mock-Ups

To the Editor:

George Michalec's article on mock-ups in your October issue well presented the case for their use as an aid in design.

When it comes to sources and cost,

(Continued on page 369)

FILL OUT COUPON FOR FACTS, SAMPLES!

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Gentlemen:
Please send complete specification data and samples of your aluminum fasteners.

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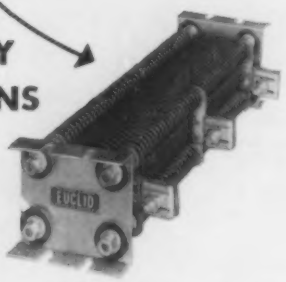

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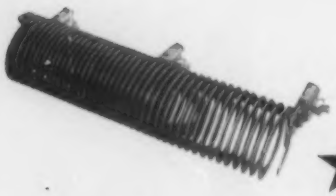
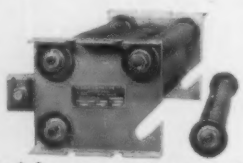


Continuous stainless steel edge-wound coil without joints eliminates hot spots, buckling and distortion.

Support rods on outside of coil permit unobstructed cooling air flow and compact design for smaller size and less weight per horsepower.

Exclusive slotted design



Slotted end frames permit removal and replacement of coil without disturbing rod assembly.

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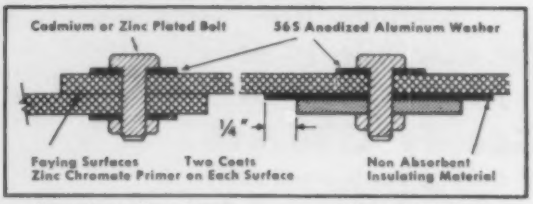
Light metals design tips



Tips on bolting magnesium to magnesium, to steel and to other metals

To join magnesium parts to each other or to steel or other metals, as shown above, cadmium or zinc plated steel bolts, anodized aluminum bolts or magnesium bolts may be used. Design-wise, a bolted joint employing magnesium members is the same as that used for other structural materials. Washers should be used when the bolt is not magnesium. Proper insulation of faying surfaces is equally important.

While magnesium may be tapped for studs and cap screws, longer threads are needed due to the low shear strength. For American Standard fine threads, thread engagement should be 2½ or 3 times the stud diameter; for coarse threads, 2 times the stud diameter is satisfactory.

Normally, where parts are often dissembled, steel inserts are used to eliminate wear and also to guard against crossing the threads in the magnesium part. When spotfacing or counterboring, a .031" radius is required at the bottom of the cut for bolts up to 1¼" in diameter. Larger bolts require a .062" radius.

Help on specific light metals joining problems is available on request. In fact, whenever light metals can be used for your parts or products, Magcoa engineers can help you design them and Magcoa fabricating facilities can produce them for you. We welcome your inquiry.

MAGNESIUM COMPANY OF AMERICA
LIGHT METALS FABRICATION DIVISION • EAST CHICAGO 27, IND.
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Is this what you are looking for?

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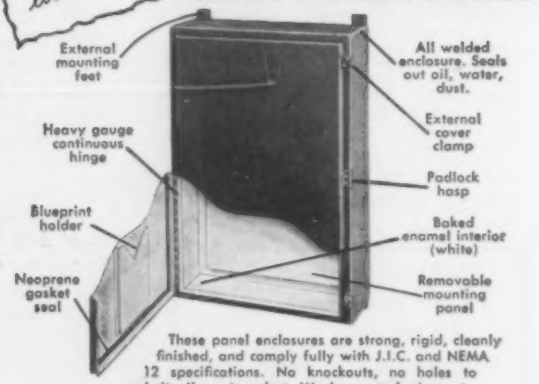
J.I.C.-NEMA Type 12
PANEL ENCLOSURES



These panel enclosures are strong, rigid, cleanly finished, and comply fully with J.I.C. and NEMA 12 specifications. No knockouts, no holes to admit oil, water, dust. We have stock sizes at low cost for fast delivery. Or, we can make any size you want. We also make J.I.C. Wiring Boxes, Troughs, Push Button Stations and Rain-proof Power Outlets. Can we help you?

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Ask your electrical jobber or write us direct.

Hoffman ENGINEERING CORPORATION
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we have found that the presence of the design engineer is often required before fabrication of the mock-up can proceed in our industrial model shop. This is partly because of the nature of the problem itself—if the engineer could furnish detailed drawings he probably wouldn't need the mock-up. In such cases it might well be more efficient to have the designer do the physical wood, metal and electrical work himself.

Contracting an entire mock-up requirement on an hourly basis with a single vendor, however, would give even the smallest companies access to mock-up facilities. This would permit greater identity of interest between designers and fabricators. The use of mock-ups procured in this fashion would assure the company of vendor-familiarity with design problems and provide professional fabrication of mock-ups at a reasonable cost.

Establishment of such a working relationship on a continuing basis would be of benefit to both large and small companies. Large companies would not have to stand the capital expense of an additional facility, while small companies could keep their designers at design work.

—R. Reinfrank
New York, N. Y.

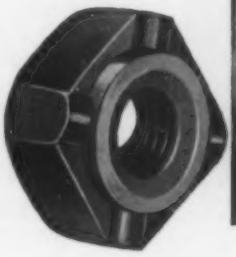
Ed—You are one hundred per cent right when you state that the designer should himself build the mock-up. The trouble is there are too many designers who don't know how to run a simple drill press.

Corrections

Several typographical errors appeared in the article "Force-Speed-Horsepower Nomograph," Oct. 1956, page 219. Equations for velocity and torque should have been $V=3.14DN/12$ and $T = DF/2$.

In the article in October, "A Review of the Heavy Press Program," Table I on page 136 lists the extrusion press installations. The designer of the 12,000-ton press for Harvey Aluminum at Torrence was incorrectly stated; this press was designed and built by the Lombard Corporation, Youngstown, Ohio, as part of the Air Force Heavy Press Program.

SPEED UP THE FABRICATING, FASTENING AND ASSEMBLING OF METAL PARTS WITH



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Midland Welding Nuts may be the answer to your dreams if you're in a business which fabricates, fastens, or assembles metal parts—OR, if you're a designer of products incorporating such parts.

Midland Welding Nuts are welded to the parts to be worked so that bolts can be turned into them speedily—without the need for any device to hold them in place.

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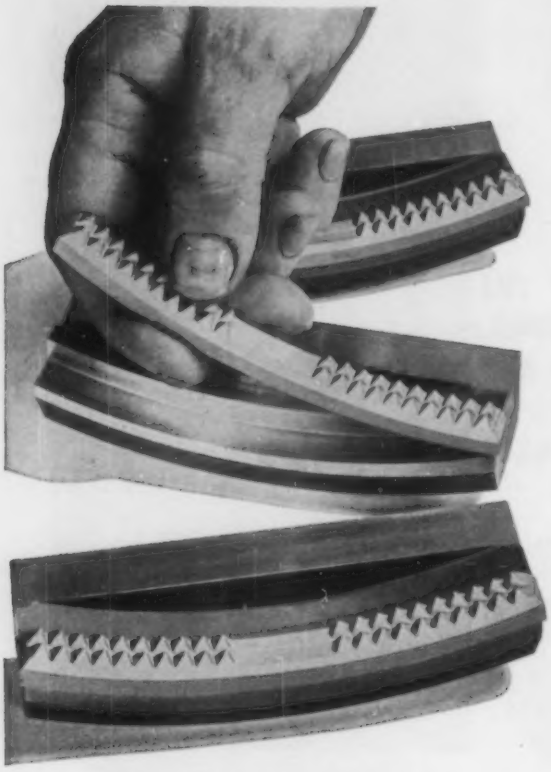

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Castings made of Colmonoy hard-facing alloys are being built into many products at points of extreme wear. They prolong the life of such products many times over.

The chuck jaws shown above are designed using castings of Colmonoy No. 5, silver brazed in place. The benefits: ten weeks of service instead of three, and then easy replacement of the worn insert instead of rebuilding the jaw itself.

Investigate Colmonoy castings. Provide your products (and production equipment) with two, three, or even thirty times longer life, and at modest cost.

Submit part drawings and a description of the wear encountered for a specific recommendation. Request Hard-Facing Manual No. 79.

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PRECISION magnetic clutches

Engineered for High Accuracy **SERVO CONTROL**

featuring:

LOW INERTIA... LONG LIFE. FAST RESPONSE... low as 10 milliseconds. HIGH CAPACITY... up to 80 oz. in. ALL combinations of CROWN TOOTH and FRICTION COUPLINGS and BRAKES.

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in the following models:

Double-Ended—Input and output on opposite ends.
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TEFLON SEAL
STOPS PIPE THREAD LEAKS instantly!
PAT. PENDING
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TRU-O-SEAL does away with messy pipe "dope" compounds, eliminates damage caused by overtightening of conventional leaky joints, and is immune to ALL known hydraulic fluids and to steam, air, water, solvents, and practically all gases and chemicals. It withstands temperatures from —100° F. to plus 500° F., saves cost and labor of special or welded fittings, and has been fully field tested and proven by leading manufacturers. Comes in ⅛" to 2½" pipe thread sizes.
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Thread TRU-O-SEAL on pipe or fitting (no messy pipe "dope" needed).
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Thread pipe or fitting 4 threads into port. Point in desired direction.
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Tighten TRU-O-SEAL to complete leakproof assembly (only light torque required).

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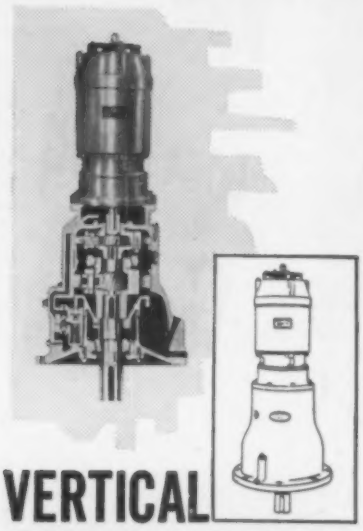

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For a compact, neat and sturdy self-contained Vertical Speed Reducer, the Philadelphia MotoReduceR is tops in design, construction and operation. The unique single casing and bolted-on motor construction . . . makes mounting and installation very simple, and of course, it eliminates base plates and couplings. The planetary, in-line reduction gears provide a rugged drive capable of withstanding severe overload conditions . . . Other features are: wide bearing span, permitting use of long, unsupported vertical shafts; Exclusive "dry-well" construction, which prevents oil leaking down output shaft.

Philadelphia MotoReduceRs can be supplied for output speeds from 9 R.P.M. to 420 R.P.M. with standard motor speeds . . . Units up to 100 H.P. are available—and a full range of horizontal units can also be supplied.

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PRESS PREVIEWS

Laboratory to Study Stainless Steel

A stainless steel research laboratory will be built by Armco Steel Corp. as part of a project to increase the facilities of their Baltimore, Md., Research Laboratory. The new building will house facilities for corrosion testing, heat treating, test melting, and welding research. An adjoining building will contain metallographic, photographic, mechanical testing laboratories, the administrative offices and a library. Other provisions in the plans provide further space for the laboratory's high temperature creep testing section, its weld shop, and its machine shop. The new Research Laboratory is expected to be completed before the end of this year.

New Source of Aluminum

The Olin Mathieson Chemical Corp. and Revere Copper and Brass, Inc., announced the formation of a jointly owned $231 million company to produce 180,000 tons a year of primary aluminum. The company, to be called the Olin Revere Metals Corp., will have the following facilities: (1) An alumina plant with a capacity of 350,000 tons per year. This plant will be built on a site still to be selected near the Gulf Coast on deep water transportation. (2) A reduction plant with 180,000 tons per year capacity, which is now under construction at Olin Mathieson's original aluminum site near Clarington, Ohio. Capacity production is expected to begin late in 1958 with some production before then. (3) A new power subsidiary wholly owned by Olin Revere, which will own two 225,000 kilowatt generating units in a new power plant at Cresap, West Va. These units will supply power to the reduction plant.

Bauxite will be processed into alumina at Olin Revere's plant on the Gulf Coast. Alumina will be transported by barge up the Mississippi

(Continued on page 373)

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YOUR BEST
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Flexibility
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Large castings, small castings, varied shapes and sizes . . . thin walls, combining strength and rigidity . . . close tolerances that eliminate machining — are every day routine at PARAMOUNT.

Our designers, sales engineers, plus modern tooling and production facilities are available for your complete die casting requirements.

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ALUMINUM ZINC MAGNESIUM
Paramount
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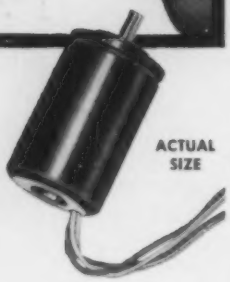
TRY THIS NEW FICo SERVO MOTOR FOR SIZE



the SM-58—a truly subminiature servo motor
Nominal Size: ⅝" diam. x 1" long (excluding shaft)
Weight: Under 1 ounce

We believe this is the smallest of small servo motors—and it's a HIGH PRECISION, VERY MODERATELY PRICED unit, with EXTREMELY HIGH torque to inertia ratio.

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Control Voltage: 26 v (max)	Ambient Range: —75 to 200 F
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THE MAN WE MEAN IS A COMPOSITE of the editorial staff of this magazine. For, obviously, no one individual could ever accomplish such a vast business news job. It's the result of many qualified men of diversified and specialized talents.

AND, THERE'S ANOTHER SIDE TO THIS "COMPOSITE MAN," another complete news service which complements the editorial section of this magazine — the advertising pages. It's been said that in a business publication the editorial pages tell "how they do it"—"they" being all the industry's front line of innovators and improvers—and the advertising pages tell "with what." Each issue unfolds an industrial exposition before you — giving a ready panorama of up-to-date tools, materials, equipment.

SUCH A "MAN" IS ON YOUR PAYROLL. Be sure to "listen" regularly and carefully to the practical business information he gathers.

McGRAW-HILL PUBLICATIONS

and Ohio Rivers to the Clarington plant, where it will be reduced to aluminum. Half of the 120,000 tons of aluminum contracted for by Olin Mathieson will be fabricated at a new rolling mill now being built near Clarington and the remainder in mid-West and West Coast plants.

Revere will use part of its 60,000 tons of aluminum at its Baltimore, Md. plant in its aluminum sheet, tube and extruded shapes departments. The balance will be used at the Dallas Division plant in Chicago where Revere has just completed a new aluminum plant from which it will ship its first aluminum sheet this month.

Aircraft Companies Expand

A major expansion program estimated to cost over $10-million was announced by Cessna Aircraft Co., Wichita, Kan. According to D. L. Wallace, president, construction will proceed in four steps: a power house, operations building and a 50,000 sq ft production flight hangar; a 44,000

sq ft engineering building of an experimental hangar; an 180,000 sq ft factory building scheduled for 1958; and an additional 120,000 sq ft of factory space to be completed by 1960.

Lockheed announces that their $4-million research laboratory in Palo Alto, for the Missile Systems division is in operation on nuclear physics, heat problems, high altitude research, outer space theory and possible applications, ultrasonic aerodynamics, new and rare materials, and other problems connected with complex weapon systems. Located in Stanford University's industrial park, this laboratory marks the completion of the first phase of the company's Bay Area building program.

The construction of a 140,000 sq

(Continued on page 375)

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GUSHER Coolant Pumps

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Illustrated is a Column type Avey Drilling Machine equipped with a 11020 B-Short Ruthman Gusher Coolant Pump.

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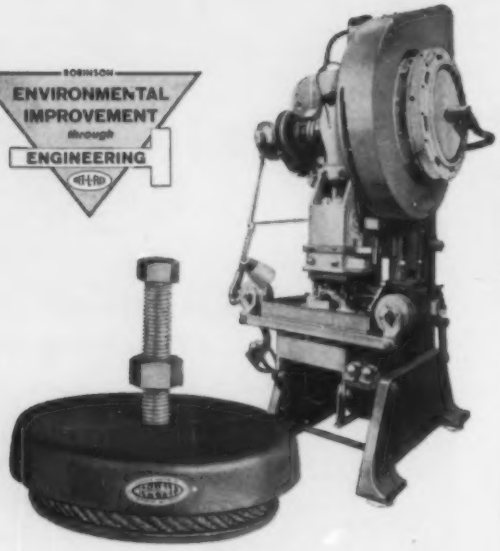

When you put a machine on Robinson all-metal industrial mounts, you accomplish three things.

- First, you lengthen machine life and increase and improve its performance.
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- Third, you provide for machine mobility when needed, with none of the time and labor expense of lagging the machine to the floor.

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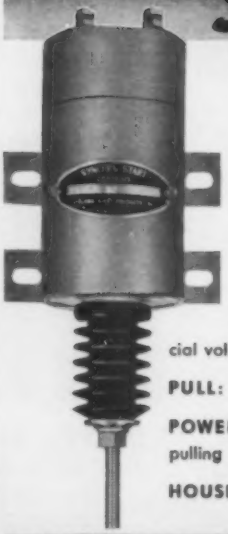
HEAVY DUTY DC *Solenoids*



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ft facility to house manufacturing, purchasing and warehousing operations for Atomics International, a division of North American Aviation, Inc., has begun in Van Nuys, Calif. Scheduled for occupancy in April 1957, the new facility will include offices and factory space to consolidate all manufacturing activities for Atomics International and provide for increased research and development activity. The company's manufacturing operations are presently centered in Compton, Calif.

Clutch Plant Expands

A new $2-million plant for the production of friction clutches has been dedicated by the Twin Disc Clutch Co., Racine, Wisconsin. The first unit of this new plant will provide 92,500 sq ft of additional floor space. The structure will be used for expanded production of clutches now turned out in the original Racine plant and at the Hydraulic Div., in Rockford, Ill. Outside of the Racine plant, the most recent expansion of Twin Disc facilities came in 1955 with the addition of a $750,000 engineering research and development center at Rockford, Ill. The company produces friction clutches and power take-offs for applications from fractional to 1050 hp. Their fluid drives include torque converters, both single-stage and three-stage, for applications from 30 to 1000 hp, and fluid couplings from ¾ to 850 hp.

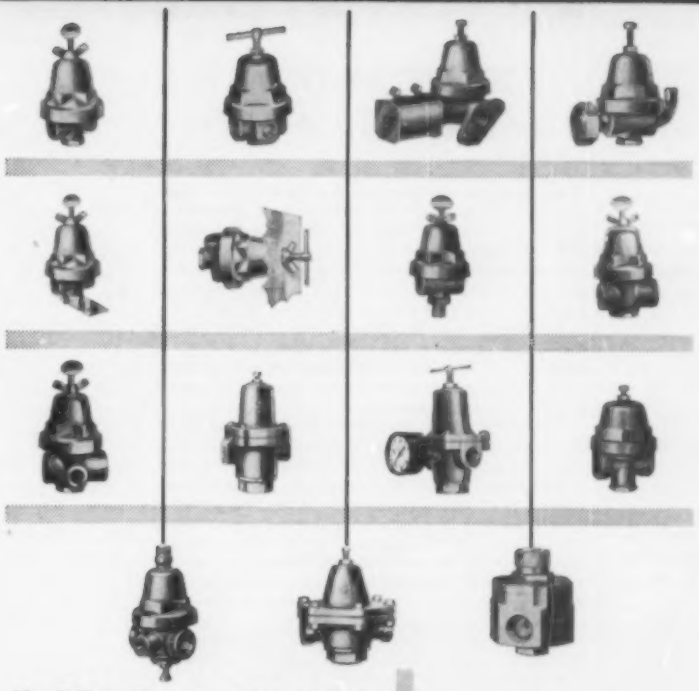
Improvements in Titanium Mill Fabrication

Improved mill fabrication of titanium was highlighted by Lee S. Busch, Dir. of Research, of Mallory-Sharon Titanium Corp., Niles, Ohio, in a lecture on forging, rolling, and mill fabrication at the second annual titanium program of the NYU College of Engineering.

According to Busch, a much better understanding of the requirements of processes and equipment for titanium production has resulted in the addition of sheet MST 6A1-4V alloy, a high-strength alloy, with good elevated temperature properties. A second major improvement described by

(Continued on page 377)

How to Reduce Air or Water Pressure in a Limited Space, Accurately and with Unusual Economy



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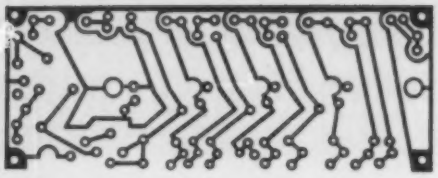

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If you have had engineering experience in any of the categories shown below, Northrop Aircraft has an attractive position for you, with many benefits. Important among them are high compensation, challenging assignments, steady advancement, recognition of initiative and ability, and continued interest in your progress. Many outstanding engineering positions are offered, as follows:

ELECTRICAL GROUP, which is responsible for the design of such things as power generation and distribution systems, rectifiers and power converters, and auxiliary systems as applied to manned aircraft, guided missiles and ground support equipment.

COMMUNICATIONS AND NAVIGATION GROUP, which is responsible for the design of C/N systems in manned aircraft and installation of guidance systems in missiles.

FIRE CONTROL RADAR GROUP, which is responsible for the installation and application of the most advanced type of fire control systems in fighter-interceptor aircraft. The work covers the installation of the equipment and associated wiring; continuing liaison with equipment manufacturers; preparation of system analysis and reports; and follow-up of system performance in the field as aircraft become operational.

INSTRUMENT GROUP, which is responsible for the design of instrument systems for manned aircraft and the installation of flight test instrumentation for guided missiles.

There are also opportunities for draftsmen with either electrical or mechanical experience.

At Northrop Aircraft you will be with a company that has pioneered for seventeen years in missile research and development. Here you can apply your skill and ability on top level projects such as Northrop's new supersonic trainer airplane, Snark SM-62 intercontinental missile, and constantly new projects. And you'll be located in Northrop's soon to be completed multi-million-dollar engineering and science building, today's finest in comfortable surroundings and newest scientific equipment.

If you qualify for any of these representative positions, we invite you to contact the Manager of Engineering Industrial Relations, Northrop Aircraft, Inc., ORegon 8-9111, Extension 1893, or write to: 1015 East Broadway, Department 4600-P, Hawthorne, California.

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Busch consists of blooming ingots directly to sheet bar or forging bar stock, eliminating intermediate conditioning operations. A third improvement is in vacuum annealing, which removes hydrogen and also helps improve mechanical properties. Mallory-Sharon has recently put in operation what they claim is the largest vacuum annealing furnace in the U. S., which is specially designed for the close control needed for titanium.

Ferrocolumbium Again Available

The mining, processing and selling of ferrocolumbium has been announced by the Molybdenum Corp. of America. Government stock-piling of columbium was recently completed, and this metallurgical alloy is again available for commercial use in unlimited quantities. According to N. F. Tisdale, chief metallurgist for MCA, the world's largest known single deposit of columbium has been discovered at Oka, Quebec, and will assure ample supply of this valuable element for future requirements.

Furnace for Stainless Steel Tubing

A bright annealing furnace for stainless steel tubing from ½ to 4 in. OD, recently installed at the Steel & Tubes Div., of Republic Steel, retains the original flat-rolled steel finish eliminating need for subsequent polishing. Abrasion and scratching of the work, particularly on heavier stainless tubing as it is drawn or pushed through the furnace is eliminated through use of wire mesh belts which carry the work through heating and cooling chambers.

New Carbon Products Plant

A new plant for the manufacture of fabricated carbon products will be constructed by Union Carbide and Carbon Corp. The plant will be operated by National Carbon Co., a division of the corporation, in Lawrenceburg, Tenn.

It will have an annual productive capacity of 12 million lb of carbon

(Continued on page 381)

Tough, hard ceramic coatings provide superior bearing surfaces

Sprayed alumina forms "sapphire-hard" surfaces highly resistant to wear, abrasion and corrosion. Ideal for bearing surfaces, seals.

Development of the new METCO THERMOSPRAY GUN for spraying high-melting-point ceramic materials at low cost opens up a variety of new practical applications. One that has produced a great deal of interest is the use of sprayed alumina coatings for bearing surfaces and mechanical seals. This THERMOSPRAY 101 Ceramic Powder produces surfaces with a hardness of 9.0 on the Moh scale, (only the diamond rates 10.0) with excellent resistance to wear, abrasion and corrosion. When used in combination with special phenolic or furane plastic sealers it provides superior protection against many acids.

Another THERMOSPRAY Powder – 201 – is zirconia which is somewhat softer than No. 101 but provides superior heat-insulating properties. Melting point of this material is 4600° F. and particle hardness 8.0 on the Moh scale.

Hard-facing alloys of the self-fluxing, nickel-boron-silicon type in powder form can also be applied with the METCO Type P THERMOSPRAY GUN. These coatings may be fused, semi-fused, or left unfused depending on the hardness desired, from RC 30 to RC 65, depending on the alloy and the process used.

The new THERMOSPRAY GUN operates without compressed air, only oxygen and acetylene being required. The free-flowing THERMOSPRAY powders are fed to the flame nozzle from a hopper atop the gun, melted and propelled to the surface to be coated. These materials are sprayed many times faster (up to 15 sq. ft. per hour – .010" thick) than has been possible with equipment previously available. Deposit efficiencies are in excess of 95%. These factors result in extremely low coating costs.

Preliminary engineering data contained in Bulletin 127 covers ceramic coatings while Bulletin 126 covers the hard-facing alloys. Either or both may be obtained by filling out the coupon below or writing on your company's letterhead. No obligation, of course.

Pump rod sprayed with alumina provides superior protection against abrasion and corrosion.

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(See last paragraph above)

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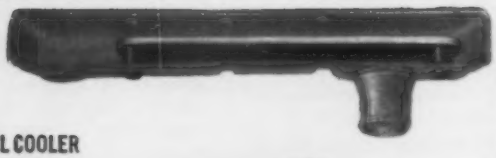

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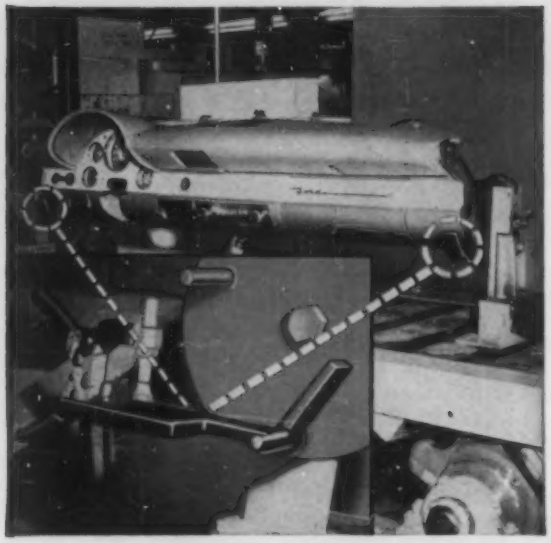

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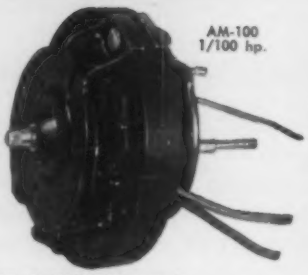

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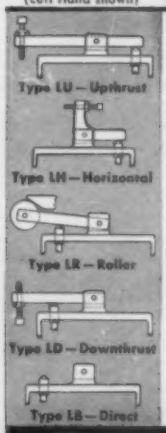

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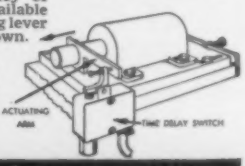

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products, with adequate provision for future expansion. This increase in productive capacity is independent of the major expansion in electrode products, recently announced by National Carbon Co., and the laboratory completed last July in Parma, Ohio.

Aircraft Instrument Laboratory

A new research and development building will house the West Coast engineering branch of Lear, Inc., Grand Rapids (Mich.) Division.

The branch plans to expand its work in machine-tool automation, system design for new high-performance fighters, and new projects in drone and missile controls. Two other Lear divisions are located at Santa Monica, one in Michigan, one in Ohio, and two in Europe.

Manufacturing Plant For Metal Stampings

A new plant, including general offices, for Fryling Manufacturing Co., in Erie, Pa., has presses ranging from 5 to 50 tons equipped with automatic feed and a staff for designing, producing, and maintaining dies. Facilities also will include stud welding, tapping, and stamping of laminated phenolics.

Nuclear Laboratory

Designed for conducting experiments in connection with the atomic-power development program, Alco Products, Inc., Schenectady, N. Y., has opened a nuclear laboratory, located on a 112 acre site. Plant includes a two-story reinforced concrete reactor room, together with a control room, "counting room" and administrative offices. The reactor room is 40x30 ft and 30 ft high, housing a 2500 gal unpressurized reactor water tank supplied by a 3500 gal storage tank in the basement of the building. The reactor tank can be emptied of water in an emergency and the reactor shut down, by the use of a quick-opening valve.

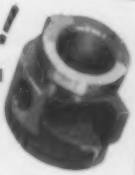
Company health physicists have established a system designed to

(Continued on page 383)

INVESTIGATE!

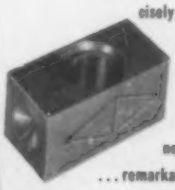
It's just good business to specify Promet Engineered Bronze Bearings, Bushings and Wearing Parts. For proof send prints and condition of operation for recommendations and quotations.

SPECIFY!



Superior service guaranteed or your money back! Special formulas, developed for specific or unusual conditions. Will not cut or stick to the shaft under ordinary operating conditions. Carry on during temporary lubrication failures. Absolutely will not powder in severest service.

SAVE!



Highest quality machining to precisely controlled tolerances. Difficult oil grooving . . . smooth groves, even around acute bends . . . no sharp edges or burrs . . . remarkably better lubrication. Also available rough cast.

SEND PRINTS and condition of operation for recommendations, quotations, literature and service data sheets.

The American Crucible PRODUCTS CO.

"Bearing Specialists Since 1919"

1317 OBERLIN AVENUE, LORAIN, OHIO, U.S.A.

Please send free literature and service data sheets on Promet Bronze.

NAME_____

COMPANY_____

STREET_____

CITY & STATE_____

A NEW FABRIC-REINFORCED MATERIAL FOR THESE BACKUP RINGS

MAKE THE GREAT

PALMETTO G-T® RING

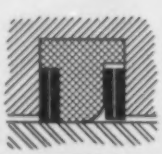
GREATER!

PALMETTO G-T Rings are now available with remarkable "Sealsaver" backups—a development that does a *perfect* job of preventing the T-ring from extruding. These unique guards for the T-ring are cut from an exclusive fabric-reinforced sheet material developed and produced by Greene, Tweed. Even though they are relatively soft and flexible G-T Ring Sealsavers possess a tensile strength of 10,000 psi in *both* directions. They will not craze or fracture during installation *or* in service—enable the PALMETTO G-T Ring to withstand pressures higher than ever.

THE GIST OF THE G-T RING

CANNOT SPIRAL...

The Palmetto G-T Ring, unlike an "O"-Ring, will not twist and turn in the groove. The "T"-form prevents spiral failure in dynamic applications.



CANNOT EXTRUDE...

Resilient "T"-section supported by "Sealsaver" non-extrusion rings on either side makes extrusion impossible. As pressure is applied "Sealsaver" rings are urged against wall, blocking path of extrusion.

In designing for less costly, just as effective substitutes for Vee, Cup and Flange packings, many design engineers have discovered the many benefits PALMETTO G-T Rings offer. Now, with the "Sealsaver" innovation PALMETTO G-T Rings as a dynamic pressure seal for rod or piston applications cannot be matched for economy or effectiveness! Write for more particulars.

PALMETTO Packings

packing more performance into every application

GREENE, TWEED & CO. North Wales, Pa.

he's working for you

THIS FELLOW IS TRAINED IN YOUR BUSINESS. His main duty is to travel the country — and world — penetrating the plants, laboratories and management councils... reporting back to you every significant innovation in technology, selling tactics, management strategy. He functions as your all-seeing, all-hearing, all-reporting business communications system.

THE MAN WE MEAN IS A COMPOSITE of the editorial staff of this magazine. For, obviously, no one individual could ever accomplish such a vast business news job. It's the result of many qualified men of diversified and specialized talents.

AND, THERE'S ANOTHER SIDE TO THIS "COMPOSITE MAN," another complete news service which complements the editorial section of this magazine — the advertising pages. It's been said that in a business publication the editorial pages tell "how they do it"—"they" being all the industry's front line of innovators and improvers—and the advertising pages tell "with what." Each issue unfolds an industrial exposition before you — giving a ready panorama of up-to-date tools, materials, equipment.

SUCH A "MAN" IS ON YOUR PAYROLL. Be sure to "listen" regularly and carefully to the practical business information he gathers.

McGRAW-HILL PUBLICATIONS

NEW APPLICATIONS AND SAMPLES OF INDUSTRIAL FELT*

*made to S.A.E. and Federal Govt. Specifications

SEND FOR YOUR FREE COPY TODAY!

CONTINENTAL FELT fills hundreds of jobs daily.

Ask for booklet PI

CONTINENTAL FELT COMPANY. INC. 1906
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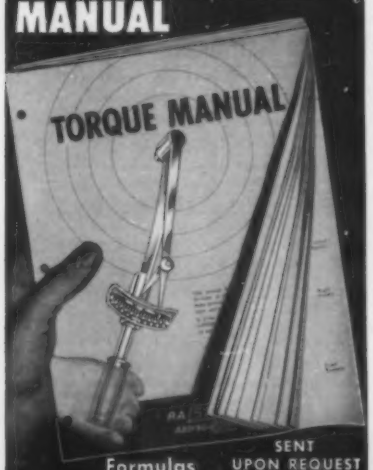
"TORQUE WRENCH" MANUAL



SENT UPON REQUEST

Formulas
Applications
Engineering Data
Screw Torque Data
Adapter Problems
General Principles

P.A. STURTEVANT CO.
ADDISON QUALITY ILLINOIS

Manufacturers of over 85% of the torque wrenches used in industry

monitor constantly any exposures which employees and residents might receive in radiation areas. Through day-to-day surveys and the keeping of careful records, they will safeguard an employee from accumulating unsafe dosages of radiation. Residents of the area will be protected by filters that cleanse air exhausted from the building. The filter provided will remove more than 99 per cent of any radioactive particles before the air leaves the stack. The air will be constantly monitored to make certain that the outflow is well below permissible discharge levels at all times. Water discharged to the Mohawk River will be similarly monitored for radioactivity.

New Divisions

DuMont Laboratories, Clifton, N. J., announced the establishment of a Field Service Dept., which will provide government and military projects with field engineers for installation, maintenance, instruction, development and production of electronic equipment.

Magnecord, Inc., Chicago, Ill., has established a Magne Matic Division to specialize in the development and manufacture of magnetic tape recording equipment for industrial uses in the field of automation and instrumentation.

Airtron, Inc., Linden, N. J., has opened a new division in Cambridge, Mass., which will specialize in the research, design, development and production of ferrite components.

Name Changes

The name of Burndy Engineering Co., Inc., Norwalk, Conn., has been changed to Burndy Corp. The company recently reorganized its activities into two divisions: the U-I Div. to serve utilities and electrical construction activities and the Omaton Div. to serve the original equipment, aircraft and military markets.

The Emergency Steel Service Corp. Skokie, Ill., has changed its name to the Rolled Steel Corp. The company obtains all of its steel from mills and its previous name is no longer applicable or descriptive of the business.

KRAISSL

• Since 1926 • In the application, design and mfg. pumps — separators — hydraulic accessories.

EQUIPMENT FOR FLUID POWER TRANSMISSION

Primary
Oil Pumps
•
Vacuum
Powered
Transmission
and
Low
Pressure
Air Service
•
Air
and
Liquid
Filters
•

What's your problem?

√ higher pumping speeds?

√ tolerance of particle-laden liquids?

√ peak suction for primary pumps?

the Kraissl-50 Roller Pump

is unmatched for dependable performance on every one of those counts.

Bulletin A-1330 has full data . . . write for it. The roller - rotor design easily handles particles that would jam more tightly - fitted mechanisms — reduces cavitation, allowing higher speed operation* — develops high suction characteristics.

* Roller mechanisms permit higher speeds with any oil than most displacement designs.

KRAISSL KRAISSL CO INC.
289 Williams Ave., Hackensack, N. J.

EMPLOYMENT OPPORTUNITIES

The Advertisements in this section include all employment opportunities—executive, management, technical, selling, office, skilled, manual, etc.

Positions Vacant
Positions Wanted
Part Time Work
Civil Service Opportunities
Selling Opportunities Wanted
Selling Opportunities Offered
Employment Agencies
Employment Services
Labor Bureaus

DISPLAYED —RATES— **UNDISPLAYED**

The advertising rate is $27.40 per inch for all advertising appearing on other than a contract basis. Frequency rates quoted on request.

An advertising inch is measured 7/8" vertically on a column—3 columns—30 inches to a page.

Subject to Agency Commission.

$1.80 per line, minimum 3 lines. To figure advance payment count 5 average words as a line.

Box Numbers—counts as 1 line.

Position Wanted ads are ½ of above rate.

Discount of 10% if full payment is made in advance for 4 consecutive insertions.

Not subject to Agency Commission.

Send NEW ADS to Classified Advertising Div. of PRODUCT ENGINEERING, P. O. Box 12, N. Y. 36, N. Y., for Jan. issue closing Dec. 17th

---

ENGINEERS

Advanced Level Openings in

design analysis

at the Small Aircraft Engine Dept. of G. E.

These are the kind of assignments that produce technical papers—and news of public interest as well.

They are in the field of new developments in small turboshaft, turboprop and turbojet power plants for aircraft—both military and commercial.

A many-sided program is under way right now at this G-E Department near Boston. It is well worth the while of an able engineer with broad design experience to look into the new opportunities that have developed here. The work involves:

- **Analysis of mechanical designs to determine how well they meet performance requirements.**
- **Analysis of the mechanical integrity of designs to ensure their suitability.**
- **Analysis of design concepts and techniques for the purpose of establishing design procedures and criteria.**
- **Study and analysis of stress and vibration characteristics of designs.**

You can count on the most extensive modern facilities, opportunities to work with the men who developed the famed T58 (with its power-weight ratio of more than 4 to 1.) Benefits are comprehensive. Location: New England resort area.

Please write in strict confidence to:
Mr. T. S. Woerz (RA7-2)
Small Aircraft Engine Dept.

GENERAL ELECTRIC

1000 Western Ave., West Lynn, Mass.

MECHANICAL ENGINEERS

Research and Development

Interesting positions open for mechanical engineers on a wide variety of projects in the following fields:

Experimental Stress Analysis — **Machine Design**
Mechanism Analysis — **Servomechanisms**

B.S. to Ph.D. in mechanical engineering with 3 to 5 years' experience in one of these fields essential. These are permanent positions offering an opportunity to use your initiative and creative ability. We offer excellent employee benefits including tuition-free graduate study.

For employment application, call CAlumet 5-2800, or write

Mr. J. A. Metzger
ARMOUR RESEARCH FOUNDATION
of Illinois Institute of Technology
10 West 35th Street Chicago, Illinois

SALARIED POSITIONS

$6,000 to $30,000

Hi-grade Engineers and Executives in all fields of industry.

GLOBE EMPLOYMENT SERVICE
42 S. 15th Street Philadelphia 2, Pa.

MANAGER PRODUCT

Research and Development

Old, well established, moderate size manufacturer process machinery. Sales on national basis. You will direct all product research activities. Starting salary $15,000. Co. pays agency fee and relocation costs.

28 E. Jackson Blvd. Chicago 4, Ill.
Monarch Personnel

PRODUCT ENGINEERS

(ME, EE, IE)

for

MILITARY

and

COMMERCIAL PROGRAMS

If you're thinking in terms of a better job for 1957, plan to take advantage of vigorously expanding manufacturing of **both** military and commercial products at this medium-sized metropolitan New York corporation.

You can make important contributions all along a product line which ranges from internationally famous Linotype . . . revolutionary and radically new Linofilm . . . hottest competitor in the duplicating and small offset printing field, Davidson Dual-Lith . . . on to electro-mechanical instruments, weapons systems, analog and digital computers.

For a stable but rewarding, challenging growth position, get in touch with our Engineering Employment department. We'll be glad to fill in the details and outline your personal growth program at Mergenthaler.

Send complete resume including education, experience and salary requirements . . . or, for more information, just drop a card or note to:

Engineering Employment Department

Mergenthaler Linotype Co.

43 Hall Street Brooklyn 5, New York

ENGINEER, DESIGN

Nuclear Aircraft Engines, Mechanical Components and Systems

From all indications the jet age will be dwarfed by the age of the application of atomic power to aircraft. An opportunity to enter this unusual field in its early stages is now offered the qualified engineer by General Electric's Aircraft Nuclear Propulsion Department.

Assignments will involve the designs of mechanical components and systems for use with aircraft nuclear power plants. For this work an ME degree or equivalent is needed, plus 3 to 5 years experience in design of mechanical devices, structures or systems analysis. Though not essential, work in aircraft power plant field is especially desirable.

Publication of research results in the appropriate classified or open literature is encouraged.

OPENINGS IN CINCINNATI, OHIO AND IDAHO FALLS, IDAHO

Address replies in confidence, stating salary requirements & location you prefer:

J. R. Rosselot
P. O. Box 132
Cincinnati, Ohio

L. A. Munther
P. O. Box 535
Idaho Falls, Idaho

GENERAL ELECTRIC

DESIGN ENGINEERS

Our needs are due to the fact that our business has doubled in the last five years. Here is an excellent opportunity to get into the dynamic field of data processing equipment and office automation. As a result of continual expansion, permanent positions are available for designers in these areas: Small mechanisms, electromechanical devices, and machine design.

MECHANICAL ENGINEER

A graduate mechanical engineer is needed to handle a program of systematic investigation and testing of new business machine devices and auxiliary products; involves some technical report writing.

RECENT GRADUATES

Are you dissatisfied with your position since graduation? A medium-sized company such as Standard Register will give you the opportunity for growth and individual expression not permitted in your present situation.

These positions are with a well established, progressive manufacturer of business forms and mechanical and electronic devices related to business machines and Integrated Data Processing. Excellent employee benefits and advancement opportunities. Replies kept confidential. Write to:

Professional Employment
THE STANDARD REGISTER COMPANY
Dayton 1, Ohio

ARE YOU THE DESIGN ENGINEER WHO:

Enjoys hard creative work—
Is interested in design and development of small mechanisms—
Would like to live in central Connecticut—
Takes pride in accomplishment—
Wants recognition as an individual—
Would like to be a member of an expanding Engineering Dept. of a top medium size company—

THIS MAY BE YOUR OPPORTUNITY

Contact: Personnel Dept.
Lux Clock Mfg. Co.
Waterbury, Conn.

WHAT
inspired
ARCHIMEDES
The driving urge to find a way to do a thing which had never been accomplished . . . then, to improve. Today, Farnsworth's electronics programs would tax the talents and imagination of these famous four . . . and
DA VINCI
more. Tomorrow will obsolete today in the fantastic industrial revolution now being created through electronics . . . The Farnsworth tradition of superior competence in electronics research, development and pro-
FARADAY
duction is now and will continue to be one of the most salable articles on the American scene. For the engineer desiring association with one of the country's pioneers in missile guidance and control, systems
ROENTGEN
test equipment, radar, countermeasures, infra-red systems, antennas, microwaves, transistor and pulse circuitry, industrial electronics products . . . Write . . .
Farnsworth
A DIVISION OF IT&T
Address Technical Employment Director
FARNSWORTH ELECTRONICS COMPANY, FORT WAYNE, INDIANA
A Division of International Telephone and Telegraph Corporation
Your resume will receive prompt, confidential attention.

SYLVANIA'S ELECTRONIC DEFENSE LABORATORY

(on the San Francisco Peninsula)

needs

MECHANICAL ENGINEERS

for research and development in electronic warfare.

The Laboratory is engaged in creative work in a variety of fields.

Specialized experience in military design or electromagnetic fields is desirable but not required. It is more important that candidates be engineers with initiative and imagination.

Liberal benefit program including part time off with pay for advanced study at nearby universities and reimbursement for one-half the cost of tuition.

Outstanding insurance, retirement and medical programs.

Our laboratory is located five miles from Stanford University, close to excellent schools and in an ideal climate.

RELOCATION EXPENSES PAID

Please send complete resume to:
J. C. Richards

ELECTRONIC DEFENSE LABORATORY
P O BOX 205
Mountain View, California

Engineer, ME EE or AE

CONTROLS DESIGN

Nuclear Aircraft Engine

First came the propeller, followed by the jet engine—and now, aircraft nuclear propulsion with its tremendous power potential. General Electric's ANP Department has a career opening for the qualified engineer who desires to achieve the professional stature his talents deserve.

The present position requires 1 to 3 years' experience in aircraft control or accessory systems design and application, and involves the design of turbine type engine controls. Both creative and analytical ability are desirable.

OPENINGS IN CINCINNATI, OHIO AND IDAHO FALLS, IDAHO

Address replies to location you prefer.

J. R. Rosselot
G.E. Co.
P.O. Box 132
Cincinnati, Ohio

L. A. Munther
G.E. Co.
P.O. Box 535
Cincinnati, Ohio

GENERAL ELECTRIC

When Writing Your Ad

Provide an indexing or subject word. Write it as the first word of your ad. If it is a Position Wanted or Position Vacant ad, make the first word the kind of position sought or offered.

The right is reserved to reject or revise all Want Advertisements.

Classified Advertising Division

PRODUCT ENGINEERING

REPLIES (Box No.): Address to office nearest you c/o This publication Classified Adv. Div.
NEW YORK: P. O. Box 12 (36)
CHICAGO: 520 N. Michigan Ave. (11)
SAN FRANCISCO: 68 Post St. (4)

POSITION VACANT

Refrigeration Engineer a progressive, mid-western manufacturing concern needs a refrigeration engineer with considerable experience and creative ability. Graduate engineer or equivalent. Minimum of 5 years experience in refrigeration design and application. Excellent opportunity for qualified man. P-3127, Product Engineering.

EMPLOYMENT SERVICE

Mechanical Engineer design 8 years experience in design of small mechanical devices such as instruments automotive parts 30-45 fee paid 10,000. Edwards Employment Agencies, Inc., Executives-Engineers 73 Warren St., New York 17, N. Y. Barcley 6-3672.

POSITION WANTED

Electro-Mechanical Engineer with extensive supervisory experience in development and design, proven inventive ability, solid background of independent work, seeks responsible position. Min. salary $12,000. PW-3564, Product Engineering.

Don't forget the

BOX NUMBER

When answering the classified advertisements in this magazine don't forget to put the box number on your envelope. It's our only means of identifying the advertisement you are answering.

SEARCHLIGHT SECTION

(Classified Advertising)

BUSINESS OPPORTUNITIES
EQUIPMENT - USED or RESALE

DISPLAYED RATE

Individual Spaces with border rules for prominent display of advertisements.

The advertising rate is $16.85 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request.

UNDISPLAYED RATE

$1.80 a line, minimum 3 lines.

Box Numbers— Care of publication count as one line.

Discount of 10% if full payment is made in advance for 4 consecutive insertions.

Equipment Wanted or For Sale Advertisements acceptable only in Displayed Style.

ALUMILITED ALUMINUM

Flat & Embossed SHEETS

Die formed panels used for store fronts, signs, trailers, displays, dryers, etc.
Anodized sheet supplied for all purposes.

LUSTRIK, Inc. Reg. T.M.
3235 Frankford Ave. Philadelphia 34, Pa.

REPLIES (Box No.): Address to office nearest you c/o This publication Classified Adv. Div.
NEW YORK: P. O. Box 12 (36)
CHICAGO: 520 N. Michigan Ave. (11)
SAN FRANCISCO: 68 Post St. (4)

CONTRACT WORK WANTED

British firm wishes to contact American Companies interested in having products made in U.K. Plant now covers presswork, cold rolling of metal sections, machining, welding, tube manipulation, chromium and other plating. CW-3525, Product Engineering.

FOR RATES OR INFORMATION ABOUT CLASSIFIED ADVERTISING,

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W. MILLER

BOSTON, 16
350 Park Square HUbbard 2-7160
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CHICAGO, 11
520 No. Michigan Ave. MOhawk 4-5800
W. HIGGENS, J. BRENNAN

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1825 Yorktown Rd.
Swifton Village, Apt. 2 REdwood 1-3238
G. MILLER

CLEVELAND, 15
1510 Hanna Bldg. SUperior 1-7000
W. SULLIVAN

DALLAS, 2
Adolphus Tower Bldg., Main & Akard Sts. Riverside 7-5064
D. BILLIAN

DETROIT, 26
856 Penobscot Bldg. WOodward 2-1793
W. STONE

LOS ANGELES, 17
1125 W. 6th St. MAdison 6-9351
H. KEELER

NEW YORK, 36
330 West 42 St. LOngacre 4-3000
S. HENRY, D. COSTER, R. LAWLESS, R. HATHAWAY

PHILADELPHIA, 3
17th & Sansom St. Rittenhouse 6-0670
E. MINGLE, H. BOZARTH

ST. LOUIS, 8
3615 Olive St. JEfferson 5-4867
W. HIGGENS

SAN FRANCISCO, 4
68 Post St. DOuglas 2-4600
W. WOOLSTON

Index of

PRODUCTS ADVERTISED

In This Issue

A

Accumulators 87
Actuators
Mechanical 63
Adhesives.....108, 117, 236, 388
Air Motors (see Motors, Air)
Aluminum Alloys....2, 101-102, 295, 395
Aluminum Coated Sheet and Strip (see Steel, Coated)
Anodes 395
Assemblies
Electrical 120-121, 387
Hydraulic 81, 299
Pneumatic 81, 254-255
Axles 271

B

Bars
Metal.....2, 4, 22-23, 78, 128, 357
Bearing Materials 395
Bearings
Ball.....40, 64, 134, 219, 225, 246, 294 326, 364
Jewel 390
Miniature 246
Needle 64, 225
Oil-less 92, 212, 336
Roller.....26-27, 40, 53, 64, 74, 225 246, 326
Self-Lubricating 381
Sleeve.....92, 118, 212, 336, 357
Bellows 52
Belts V 48, 124
Bi-Metal 227
Blowers 360
Bolts.....54, 256, 290, 343, 344, 352
Boosters 87
Boots 52
Brakes
Hydraulic 279
Mechanical 279
Pneumatic 279
Brass 45, 283
Brazing
Alloys 268
Bronze 221, 381
Brushes, Electrical 387
Bushings 336, 357, 381

C

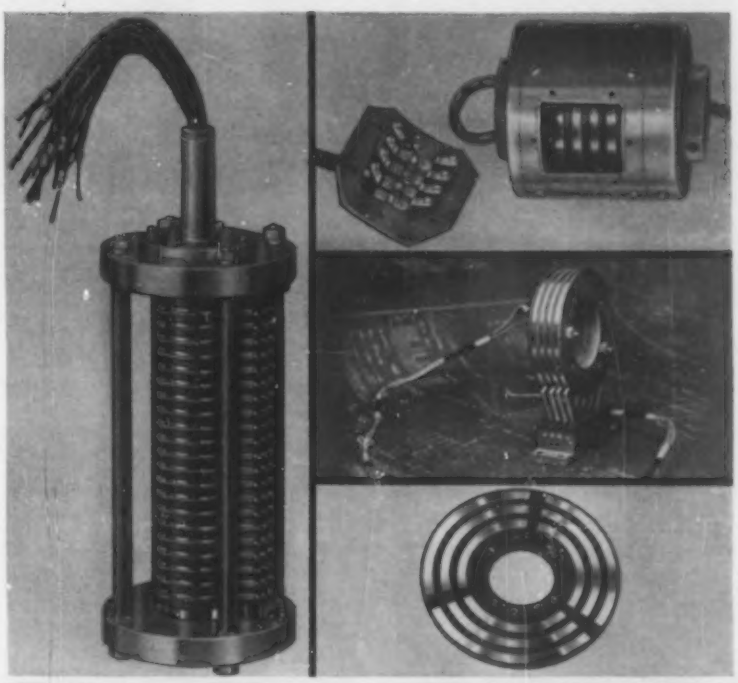
Cabinets 368
Cam Followers 366
Cams 361
Carbon 397

Continued on p. 388

SLIP RING ASSEMBLIES • BRUSH ASSEMBLIES • BRUSHES

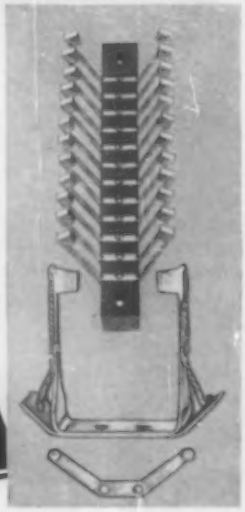
CONTACTS . . . one or all

- designed for your application
- built to your specification



Superior Assemblies Have Brushes and Contacts Made by Superior

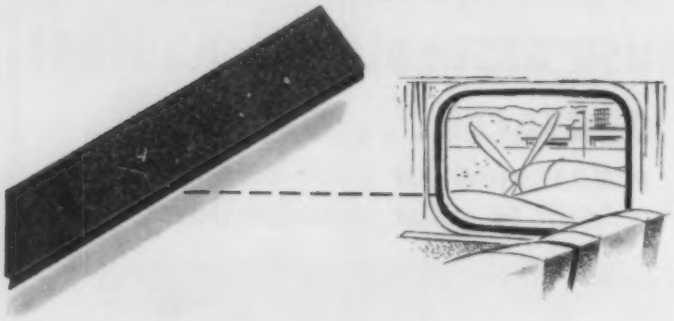
Seen above are several jobs which have solved problems for the manufacturers of end products. Sometimes we build a slip ring assembly which follows the customer's design, or we will design and build an assembly which suits your equipment. Practically any size or design can be met. Let us quote you on a complete Superior package unit including rings, brush holders, brushes and contacts of our own manufacture.



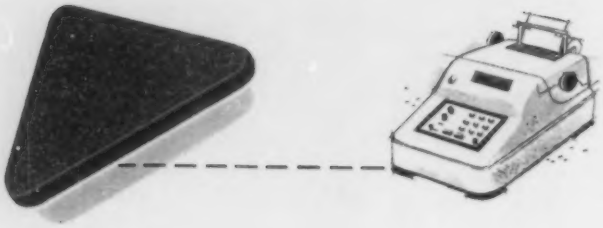
SUPERIOR CARBON PRODUCTS, INC.
9115 GEORGE AVENUE • CLEVELAND 5, OHIO

SCP SUPERIOR CARBON BRUSHES *Since 1919*

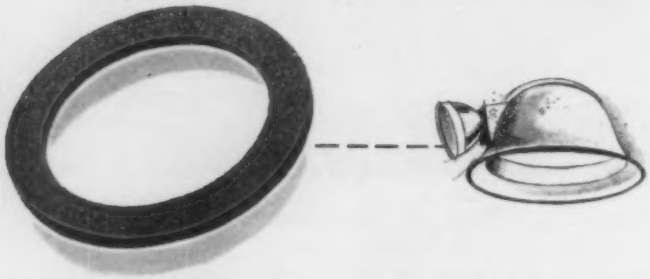
Insulates



Skid-proofs

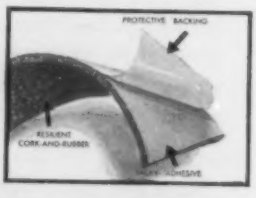


Absorbs shocks



Armstrong DK-153 is a resilient cork-and-sponged-rubber composition with a pressure-sensitive adhesive backing. DK-153 is used today in many different ways in hundreds of industrial products . . . it serves as an insulating strip in aircraft windows, skid-proofs office accounting machines, cushions shock and prevents damage in mine safety equipment.

You can get DK-153 in rolls, strips, sheets or die-cut shapes, in thicknesses from 1/32 to 3/16 inch. In any form DK-153 is easy to apply: just peel off its protective covering and press material into place. (DK-153 is also available without adhesive backing.) For samples, write to Armstrong Cork Company, 7312 Irvin St., Lancaster, Penna.



Armstrong DK-153

. . . used wherever performance counts

Index of PRODUCTS ADVERTISED

In This Issue

•

Continued from p. 387

Carbon Parts 92, 397
Casters 253
Castings 50-51, 301, 359
Castings, Precision Investment...70, 244
Ceramics 97, 106
Chains
  Conveyor 259, 298
  Roller 12, 259
  Silent 12, 259
Chemical Treatments..252, 318, 322, 354
Chromium Alloys 42-43
Clad Metals 31, 227
Clamps, Hose 328
Clips, Electrical 324
Clutches
  Mechanical 245, 271, 320, 323, 348 364, 370, 400
  Pneumatic 245, 323
Coatings.....106, 117, 252, 318, 322, 340 354, 376, 380
Cold Headed Parts.....256, 344
Collector Rings 387
Compressors 276
Connectors
  Electrical 120-121, 313
  Hose.....59, 75, 81, 327
  Tube.....59, 75, 81, 327
Contactors 96
Contacts & Contact Materials..... 227 320, 387
Controllers 328
Control Panels & Switchboards..96, 373
Controls
  Electrical..46, 84-85, 96, 242-243, 262
  Electronic 46, 96
  Hydraulic 6, 299
  Mechanical 284
  Pneumatic 6
Conveyors 298
Copper & Copper Alloys.....221, 395
Cords 355
Cork Compositions 15, 388
Counters 17
Couplings (see Connectors, Electrical)
Couplings
  Electrical 281
  Hose 81, 362
  Hydraulic 263, 362
  Mechanical 263, 293
  Tube 81
Cylinders
  Hydraulic 44, 87, 105
  Pneumatic 44, 87

D

Dials 373

Index of

PRODUCTS ADVERTISED

In This Issue

●

Die Castings.....331, 339, 346, 363, 371

Dies 317

Drafting
Instruments 35
Machines 33, 119
Supplies.....35, 340, 364, 366

Drives
Adjustable Speed 48, 281
Right-Angle 308
Variable Speed.....69, 259, 272, 315

E

Electrical & Electronic Components, Custom Made (see also Production Services) 305

Engineering Services (see also Production Services)..101-102, 130, 341 372, 374

Engines 367

Expanded Metals 350

Extrusions
Metallic....2, 33-34, 78, 233, 295, 368
Non-Metallic 97, 314, 365

F

Fabricated Plastics (see Plastics, Fabricated)

Fabricated Steel (see Plate, Fabricated, Sheet Fabricated, Structural Forms & Shapes, see Weldments)

Fabrics, Coated 103

Fastening Methods.....79, 132, 297, 312 352, 367

Felt 269, 383

Fibre 62, 280

Fibre Glass 310

Filters
Air.....254-255, 365, 383, 389
Hydraulic 319, 383, 389

Fittings, Hose, Pipe & Tube..59, 75, 327

Flexible Couplings 293

Flexible Shafts 229, 324

Flux 395

Forgings.....2, 33-34, 86, 271, 277, 283

Friction Materials 270

Furniture, Engineering Dept..... 366

G

Gaskets 15, 123, 348

Gear Motors (see also Motor Reducers) 3rd Cover, 28-29, 36, 69, 83, 91, 114, 272

Gears.....1, 76-77, 89, 237, 257, 282

Generators
A-C 271, 353
D-C 271, 353
High Frequency 353

Continued on p. 390

FILTER FORUM

Question:

What facts should a product designer determine before choosing a filter?

Success of any pre-planned filter installation is dependent on calculations which are fundamental to the special field of filter design. As a rule, the data is simple to determine. Where unusual conditions exist, Purolator will design special filters to handle them.

Answer:

These five facts: 1. Degree of filtration, 2. Flow rate, 3. Contamination to be removed, 4. Viscosity of fluid, 5. Provision for cleaning or replacement.

1. Degree of filtration of a filter medium means the size of the smallest particles filtered out with 98% efficiency—expressed in microns for sizes less than .001 inch.

2. Flow rate is the flow that a clean filter unit will handle calculated in terms of the fluid's viscosity and the allowable pressure drop through the filter.

3. Contaminants are any elements from water to dust that shouldn't be there—the materials themselves, their quantity, their size.

4. As a rule, the pressure drop through a filter for a given flow rate is proportional to its viscosity.

5. Provision for cleaning or replacement depends on the predicted effects of a temporary lack of filtration while the cleaning or replacement is accomplished. Can the equipment operate temporarily without filtration, for example, can it be shut down periodically — or will two filters be needed; one for cleaning, one for service.

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Index of PRODUCTS ADVERTISED

In This Issue

Continued from p. 389

Glass 335
Graphic Charts 381

H

Handles & Knobs 374
Hard Surfacing 88, 370, 377
Heating Units 324, 378, 381
Hermetic Seals 235
Hose & Tubing 59, 75

I

Inspection Equipment 287
Insulation 310

J

Jewels 390

L

Laminated Plastics (see Plastics, Laminated)
Latches 238
Lead 395
Liquid Level Controls 344
Low Temperature Melting Alloys 362
Lubricants 340
Lubricating Equipment ... 95, 125, 254-255 321

M

Magnesium Alloys 368, 395
Magnet Wire 20-21
Manganese Alloys 42-43
Marking Machines & Tools 365
Metal Bonded to Plastic 280
Moldings
Plastics (see Plastic Parts)
Powdered Metal (see Powered Metal Parts)
Rubber (see Rubber Parts)
Molybdenum Alloys 107
Motor Reducers (see also Gear Motors) 28-29, 371
Motor Starters 96
Motors, A-C
Fractional ... 55, 60-61, 110-111, 239-240 264, 304, 340
Integral .. 110-111, 126-127, 267, 272, 340 353
Sub-Fractional 264, 285, 380

Index of

PRODUCTS ADVERTISED

In This Issue

•

Motors, Air 276
Motors, D-C
Fractional...55, 60-61, 110-111, 239-240 264, 304
Integral ...84-85, 110-111, 126-127, 267 272, 353
Sub-Fractional 264
Motors, Hydraulic 56-57, 105
Mountings 316

N

Name Plates 373
Nickel Alloys 112
Nuts..37, 47, 54, 66, 79, 132, 290, 314, 324 336, 343, 344, 348, 362

P

Packings 352, 382, 394
Perforated Metals 304
Pillow Blocks 40, 336
Pilot Lights 96
Pipe 78
Plastic Film 93
Plastic Parts..130, 305, 331, 333, 356, 365
Plastics.....18-19, 71, 296, 303, 329, 365
Plastics Fabr'cated 329, 356
Plastics Laminated.....58, 280, 329, 333
Plates 4, 78
Plates, Clutch 348
Porcelain 265
Potentiometers 286
Powdered Metal Parts..4th Cover, 73, 82 118, 212, 346, 357
Power Packs
Hydraulic 299
Power Take-offs 271, 348
Precious Metal Alloys..... 320
Production Machines & Processes.....109 234, 288, 366
Production Services (see also Engineering Services).....261, 305. 374
Pumps
Air 276, 383
Liquid.....56-57, 105, 116, 349, 373, 383 391
Vacuum 276, 383

R

Radioactive Sources & Materials..... 373
Recorders 46, 209
Regulators
Hydraulic 375
Pneumatic 254-255, 375

Continued on p. 392

Lubrication
WITH A "SENSE" OF DIRECTION

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Photo courtesy Western Gear Corporation, Seattle, Washington

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Index of PRODUCTS ADVERTISED

In This Issue

•

Continued from p. 391

Relays 96, 210, 344, 396
Reproduction Equipment 35, 119
Reproduction Supplies 35
Resins 18-19, 90, 353
Resistors 8, 368
Retaining Rings 39, 340
Rivets 79, 288, 290, 352
Rod Ends..... 100
Rods
Metallic 2
Non-Metallic 58, 296
Rolls 356
Rubber 113, 115, 231, 365
Rubber-Bonded-to-Metal 316
Rubber Parts..2nd Cover, 16, 52, 115, 314 365
Rust Proofing 354

S

Screw Fasteners 104
Screws....14, 22-23, 54, 256, 290, 307, 314 324, 343, 344
Screw Thread Inserts..... 310
Sealers 117
Seals.....2nd Cover, 72, 250, 325, 370, 382
Servomechanism Components 372
Shapes, Rolled Formed.....2, 337, 345
Sheets
Metal.....2, 4, 22-23, 78, 249, 334
Plastic.....58, 130, 296, 307
Rubber 103
Shims 278
Silicone Rubber 103
Silicones 67-68
Solenoids 374
Specialty Fasteners (Pipe Hangers, Special Cold Headed Parts, etc.).. 79 94, 104, 132, 238, 256, 314, 336, 343, 348
Speed Reducers ...28-29, 99, 237, 251, 348
Splines 63
Springs 266, 363, 392
Sprockets 12, 257
Stampings 271, 305, 328
Steel
Alloy..24-25, 42-43, 50-51, 223, 342, 347
Carbon 49, 342
Coated 289
Stainless.....4, 24-25, 42-43, 78, 80, 249 309, 314, 359
Strainers 383
Strip, Metallic.....2, 4, 49, 78, 249
Structural Forms & Shapes..... 345
Studs 256

Index of

PRODUCTS ADVERTISED

In This Issue

Switches 30, 38, 96, 380, 396
Swivel Joints 291

T

Terminals & Terminal Boards..... 106
Testing Machines & Equipment..287, 338
Thermostats 11, 32
Timers.....248, 258, 282, 306, 341, 358
Timing Motors 248, 358
Titanium 274
Tools 383
Torque Converters 271
Tracing Cloth 340
Transducers 286
Transmissions 260, 271
Traps (Steam) 98
Tubing
Flexible Metal 75
Lock-Seam 2, 247
Plastic 58, 296
Seamless 2, 41, 311
Welded.....2, 22-23, 65, 233, 311

U

Universal Joints 271, 273

V

Valves
Air.....6, 122, 254-255, 275
Control 122, 275
Hydraulic 6, 105, 353, 356
Solenoid 6
Vibration Dampers
Mechanical 316, 374
Vibration Mountings 338, 374
Vibratory Equipment 338

W

Washers 290, 328
Washers (see Packings)
Wear Materials 381
Welding
Equipment 302, 332
Nuts 369
Supplies 332
Wheels 374
Whiteprinting Equipment 300
Wire.....4, 20-21, 78, 292, 305, 399
Wire & Cable..... 355
Wire Cloth 241, 393
Wiring Devices 368

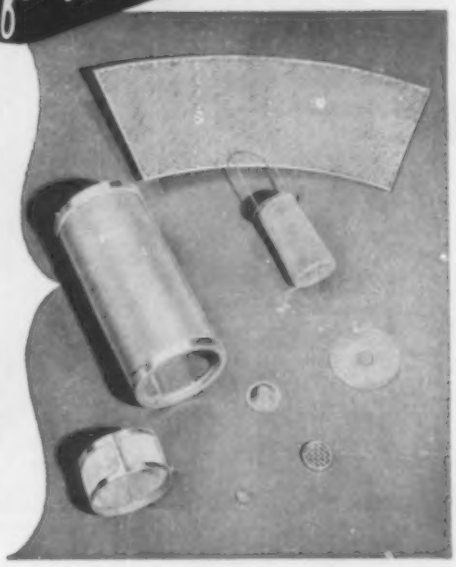
Z

Zinc 395
Zinc Coated Sheets.....22-23, 289

Our Slogan...

NEWARK for ACCURACY

applies also to "fabricated" wire cloth inserts



Our slogan, Newark for Accuracy, has long been known to users of bulk wire mesh cloth, wire space cloth and wire filter cloth. It is now becoming more and more familiar to users of parts fabricated from wire cloth made by a fast-growing division of our company.

These parts, similar to those illustrated, are fabricated or assembled for our customers by skilled workmen in our large department specializing in this work. We are equipped to handle small lots or in production quantities of anything from large jet intake screens to tiny fuel pump strainers

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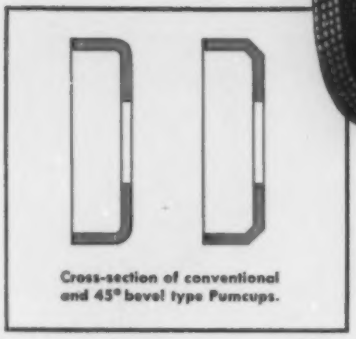

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TRADE MARK
Pumcups

INDEX TO ADVERTISERS

This index is published as a convenience to the readers. Every care is taken to make it accurate but PRODUCT ENGINEERING assumes no responsibilities for errors or omissions.

A

AMP, Inc. 313
Accurate Spring Mfg. Co. 266
Adams & Westlake Co. 210
Advanced Vacuum Products, Inc., Div. of General Ceramics Corp. 235
Aeroquip Corp. 59
Airborne Accessories Corp. 308
Ajax Flexible Coupling Co. 293
Allegheny Ludlum Steel Corp. 359
Allen-Bradley Co. 96
Allen Mfg. Co. 37
Allied Research Products, Inc. 322
Allis-Chalmers Mfg. Co. 48, 84-85, 116
Alpha Molykote Corp. 340
Aluminum Co. of America 33-34, 367
American Brass Co. 45
American Chemical Paint Co., Metal-working Chemical Div. 318
American Crucible Products Co. 381
American Felt Co. 269
American Lava Corp., Subs., Minnesota Mining & Mfg. Co. 97
American Metal Hose Div., American Brass Co. 75
American Steel & Wire Div., U. S. Steel Corp. 24-25, 78
Apex Machine & Tool Co. 273
Armco Steel Corp. 4
Armstrong Cork Co. 15, 117, 123, 388
Arwood Precision Casting Corp. 244
Automotive & Aircraft Div., American Chain & Cable Co. 284
Automotive Gear Works, Inc., Subs. of Eaton Mfg. Co. 1

B

B/W Controller Corp. 344
Babcock & Wilcox Co., Tubular Products Div. 311
Bakelite Co., Div., Union Carbide & Carbon Corp. 303
Bantam Bearings Div., Torrington Co. 64
Barksdale Valves 6
Barry Controls, Inc. 338
Belden Mfg. Co. 355
Bethlehem Steel Co. 347
Bird Co., Inc., Richard H. 390
Boston Gear Works 28-29
Bound Brook Oil-less Bearing Co. 212
Bourns Laboratories 286
Bower Roller Bearing Div., Federal-Mogul-Bower Bearings, Inc. 74
Bridgeport Brass Co. 221
Bruning Co., Inc., Charles 35, 119
Bundy Tubing Co. 247
Bunting Brass & Bronze Co. 357

C

Cambridge Wire Cloth Co. 241
Cameron Iron Works, Inc., Special Products Dept. 277
Cannon Electric Co. 120-121
Carpenter Steel Co. 80
Cash Valve Mfg. Corp., A. W. 375
Central Foundry Div., General Motors Corp. 50-51
Cerro De Pasco Corp. 362
Char-Lynn Co. 362
Chase Brass & Copper Co. 86
Chatillon & Sons, John 392
Chemical Products Corp. 380
Chicago Molded Products Corp. 130
Chicago Rawhide Mfg. Co. ..... 2nd Cover

INDEX TO ADVERTISERS

Chiksan Co. 291
Cleveland Cap Screw Co. 256
Climax Molybdenum Co. 107
Columbia-Geneva Steel Div., U. S. Steel Corp. 24-25, 78
Cone-Drive Gears Div., Michigan Tool Co. 251
Continental Felt Co. 383
Corning Glass Works 335
Cramer Controls Corp. 358

D

Dana Corp. 271
Darling Valve & Mfg. Co. 394
DeLaval Steam Turbine Co. 237
Denison Engrg. Co., Subs. of American Brake Shoe Co. 56-57
Detroit Power Screwdriver Co. 234
Diamond Mfg. Co. 304
Douglas Aircraft Co. 330
Dow Chemical Co. 71
Dow Corning Corp. 67-68
Draftray Co. 364
du Pont de Nemours & Co., (Inc.), E. I., Elastomers Div. 231
du Pont de Nemours & Co. (Inc.), E. I., Fabrics Div. 103
du Pont de Nemours & Co. (Inc.), E. I., Film Dept. 93
du Pont de Nemours & Co. (Inc.), E. I., Textile Fibers Dept. 62
Durakool, Inc. 282
Dynamatic Div., Eaton Mfg. Co. 281

E

Eagle Signal Corp. 258
Eastman Kodak Co., Special Products Sales Div. 287
Eastman Mfg. Co. 81
Eaton Mfg. Co., Foundry Div. 301
Edgemont Machine Co. 364
Elastic Stop Nut Corp. of America 47
Elco Tool & Screw Corp. 344
Electro Dynamics Div., General Dynamics Corp. 272
Electro-Flex Heat, Inc. 381
Electro Metallurgical Co., Div., Union Carbide & Carbon Corp. 42-43
Enjay Co., Inc. 113
Euclid Electric & Mfg. Co. 368

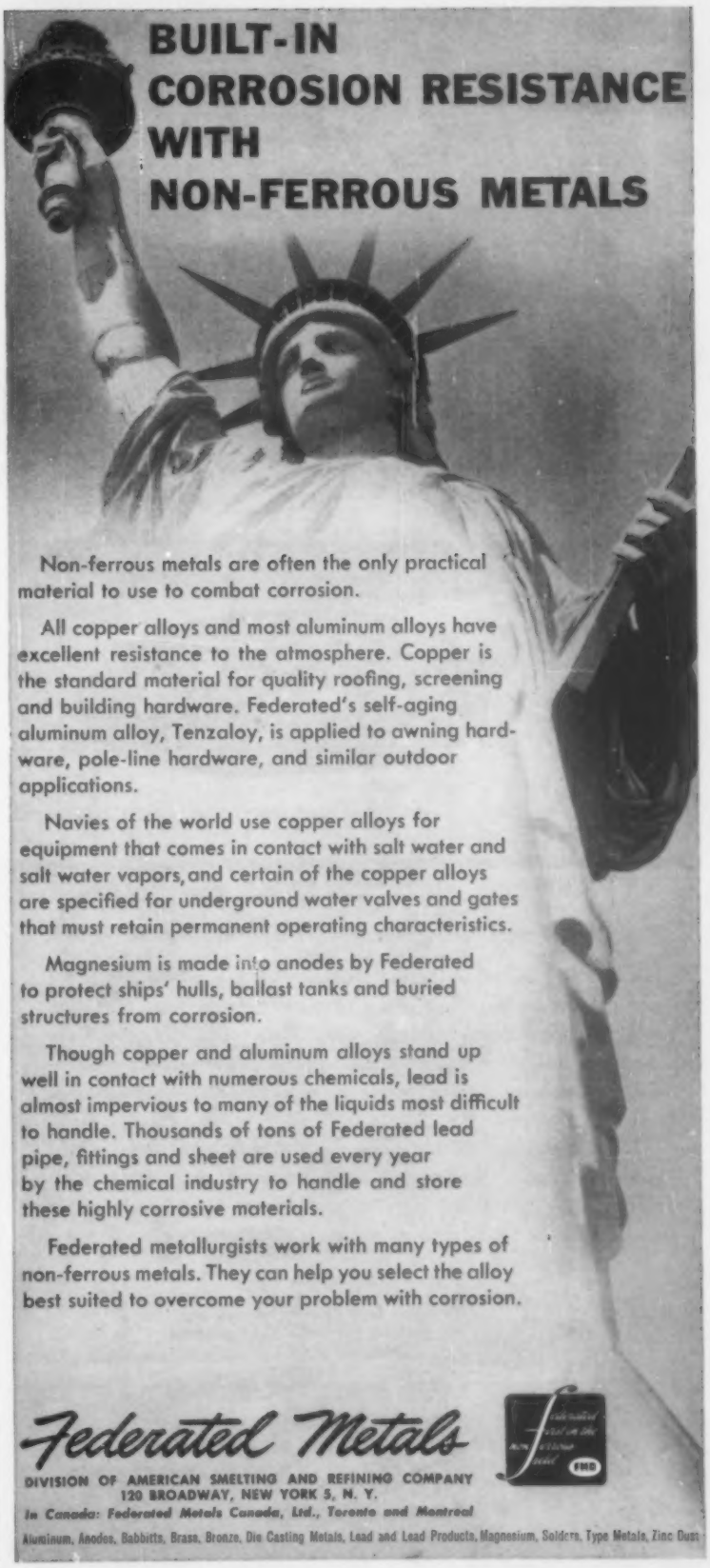
F

Fafnir Bearing Co. 219
Fairchild Engine & Airplane Corp., Stratos Industrial Products Branch 275
Farval Corp. 95
Fasteners, Inc. 312
Faultless Caster Corp. 253
Federal Bearings Co., Inc. 294
Federal Die Casting Co. 363
Federal-Mogul Div., Federal-Mogul-Bower Bearings, Inc. 118
Federated Metals Div., American Smelting & Refining Co. 395
Fellows Gear Shaper Co. 109
Fenwal, Inc. 32
Firestone Plastics Co., Chemical Sales Div., Div. of Firestone Tire & Rubber Co. 90
Firestone Tire & Rubber Co., Guided Missile Div. 214
Flanders Mill, Inc. 365
Foote Bros. Gear & Machine Corp. 99
Ford Instrument Co., Div. of Sperry-Rand Corp. 372
Formsprag Co. 400
Frenchtown Porcelain Co. 106

G

Garrett Co., Inc., George K. 328
Gast Mfg. Corp. 276

(Continued on P. 396)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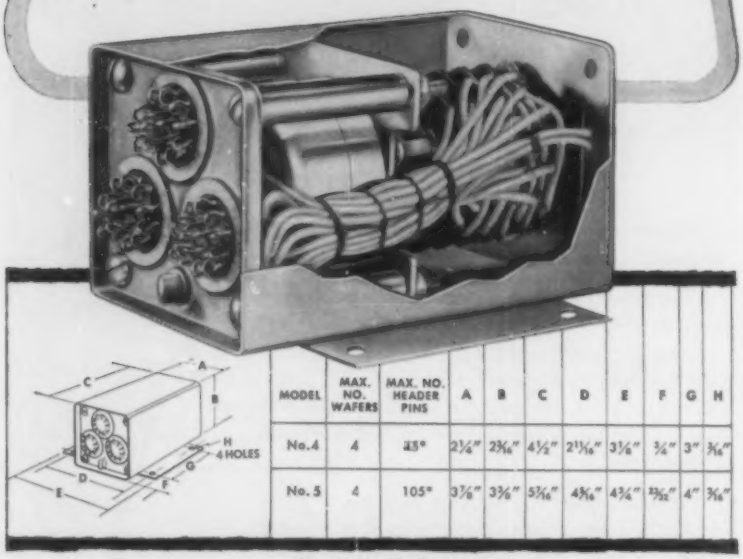

MODEL	MAX. NO. WAFERS	MAX. NO. HEADER PINS	A	B	C	D	E	F	G	H
No. 4	4	45°	2¼"	2⅜"	4½"	2¹⁵⁄₁₆"	3⅛"	¾"	3"	⅜"
No. 5	4	105°	3⅞"	3⅜"	5⅛"	4⅝"	4¾"	³³⁄₃₂"	4"	⅜"

*Circuits should allow for header pins to carry arc suppression items externally

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INDEX TO ADVERTISERS

(Continued from P. 395)

General Aniline & Film Corp., Ozalid Div. 300
General Dynamics Corp., Electro Dynamics Div. 272
General Electric Co., Apparatus Dept. 46, 60-61, 69
General Electric Co., Construction Materials Div. 20-21
General Industries Co. 285
General Plate Div., Metals & Controls Corp. 31
Gits Bros. Mfg. Co. 321
Gleason Works 89
Goodrich Co., B. F. 79
Graphic Systems 381
Great Lakes Steel Corp., Div., National Steel Corp. 223
Greene, Tweed & Co. 382
Gries Reproducer Corp. 331
Grip Nut Co. 362

H

Handy & Harman 268
Hannifin Corp. 122
Harper Co., H. M. 290
Harvey Aluminum Sales, Inc. 295
Haydon Mfg. Co., Inc. 248
Haynes Stellite Co., Div. of Union Carbide & Carbon Corp. 70
Helm Co. 100
Heinze Electric Co. 380
Hofman Engrg. Corp. 368
Hoke, Inc. 356
Holo-Krome Screw Corp. 307
Holtzer-Cabot Div., National Pneumatic Co., Inc. 304
Hommel Co., O. 341
Houghton Laboratories, Inc. 353
Howard Industries, Inc. 264
Huck Mfg. Co. 352
Hunt Machine Co., Rodney 356
Hyatt Bearings Div., General Motors Corp. 26-27

I

Illinois Gear & Machine Co. 257
Illinois Tool Works 76-77
Imperial Tracing Cloth 340
Industrial Retaining Ring Co. 341
Industrial Timer Corp. 306
Instrument Specialties Co., Inc. 363
International Nickel Co., Inc. 112

J

Jahn Mfg. Co., B. 317
Jeffrey Mfg. Co. 298
Jergens Tool Specialty Co. 374
Johns-Manville Corp. 250, 270
Johnson Rubber Co. 365
Jones & Laughlin Steel Corp. 233

K

Kalamazoo Div., N. Y. Airbrake Co. 105
Kato Engineering Co. 353
Kaydon Engineering Corp. 225
Keystone Carbon Co. 73
Kilian Mfg. Corp. 364
Koven & Bro., Inc., L. O. 261
Kraissl Co., Inc. 383

INDEX TO ADVERTISERS

L

L. O. F. Glass Fibers Co. 310
Laminated Shim Co., Inc. 278
La Salle Steel Co. 128
Leland, Inc., G. H. 396
Lewellen Mfg. Co. 260
Lincoln Electric Co. 332
Linde Air Products Co., Div. of Union Carbide & Carbon Corp. 88
Linear, Inc. 352
Link-Belt Co. 12, 40
Long Mfg. Div., Borg-Warner Corp. ... 378
Lord Mfg. Co. 316
Lukens Steel Co. 342
Lux Clock Mfg. Co. 341

M

McLouth Steel Corp. 249
MacLean-Fogg Lock Nut Co. 348
Magnesium Co. of America 368
Mallory & Co., Inc., P. R. 8
Mallory-Sharon Titanium Corp. 274
Manheim Mfg. & Belting Co. 124
Marvel Engineering Co. 319
Master Electric Co. ..... 3rd Cover
Matthews & Co., Inc., Jas. H. 365
Mayline Co. 366
Merkle-Korff Gear Co. 91
Metals & Controls Corp., General Plate Div. 31
Metals & Controls Corp., Spencer Thermostat Div. 30
Metallizing Engineering Co., Inc. 377
Mica Insulator Co., Subs. of Minnesota Mining & Mfg. Co. 333
Michigan Tool Co., Cone-Drive Gears Div. 251
Micro Switch, a Div. of Minneapolis-Honeywell Regulator Co. 38
Midland Steel Products Co. 369
Milford Rivet & Machine Co. 288
Miller Fluid Power Div., Flick-Reedy Corp. 87
Minneapolis-Honeywell Regulator Co., Industrial Div. 262
Minnesota Mining & Mfg. Co. 108
Monsanto Chemical Co. 18-19
Moraine Products Div., General Motors Corp. 82
Morganite, Inc. 397
Morse Chain Co., A Borg-Warner Industry 259
Mt. Vernon Die Casting Corp. 339

N

National Cash Register Co. 379
National Machine Products Co. 336
National Pneumatic Co., Inc., Holtzer-Cabot Motor Div. 304
National Screw & Mfg. Co. 343
National Seal Div., Federal-Mogul-Bower Bearings, Inc. 72
National-Standard Co. 49
National Tube Div., U. S. Steel Corp. 24-25, 41, 78
Newark Wire Cloth Co. 393
New Departure Div., General Motors Corp. 134
New Hampshire Ball Bearings, Inc. ... 246
New York Air Brake Co., The 105
Ney Co., J. M. 320
Nicholson & Co., W. H. 98
Norgren Co., C. A. 254-255
Northrop Aircraft, Inc. 376

O

Onan & Sons, Inc., D. W. 367

(Continued on P. 398)

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INDEX TO ADVERTISERS

(Continued from P. 397)

P

Packard Electric Div., General Motors Corp. 55
Paramount Die Casting Co. 371
Parker Appliance Co. 325, 327
Parker-Hartford Corp. 361
Parker Kalon Div., General American Transportation Corp. 54
Parker Rust Proof Co. 354
Parker White-Metal Co. 346
Peerless Electric Co., Fan & Blower Div. 360
Peerless Electric Co., Motor Div. 340
Penn Metal Co., Inc. 350
Penn Salt Mfg. Co., Metal Processing Dept. 252
Philadelphia Gear Works, Inc. 371
Pneu-Trol Devices, Inc. 380
Porcelain Enamel Institute, Inc. 265
Pratt & Whitney Aircraft Co. 398
Process Gear Co., Inc. 282
Progressive Mfg. Co., Div. of The Torrington Co. 314
Pure Carbon Co., Inc. 92
Purolator Products, Inc. 389
Pyramid Mouldings, Inc. 337

R

Randall Graphite Bearings, Inc. 336
Rawson Coupling Div., O. S. Walker, Inc. 320
Reeves Div., Reliance Electric & Engrg. Co. 315
Reeves Instrument Corp., Subs., Dynamatic Corp. of America 370
Remington Rand 351
Republic Steel Corp. 22-23
Resistoflex Corp. 296
Reuland Electric Co. 267
Revere Copper & Brass, Inc. 2
Revere Corp. of America, Subs. of Neptune Meter Co. 292
Reynolds Metals Co., Parts Div. 101-102
Richardson Co. 329
Robinson Aviation, Inc. 374
Rochester Products Div., General Motors Corp. 65
Rockford Clutch Div., Borg-Warner Corp. 348
Roth Rubber Co. 115
Rubber & Asbestos Corp. 236
Ruthman Machinery Co. 373

S

SKF Industries, Inc. 326
Saginaw Steering Gear Div., General Motors Corp. 63
Sanborn Co. 209
Sciaky Brothers, Inc. 302
Scovill Mfg. Co. 238
Sharon Steel Corp. 309
Simmons Fastener Corp. 94
Sinko Mfg. & Tool Co. 356
Smith Bearing Co. 366
Smith Corp., A. O., Electric Motor Div. 126-127
South Chester Corp., Southco Div. 104
Spencer Thermostat Div., Metals & Controls Co. 30
Standard Pressed Steel Co. 14, 66
Stevens Mfg. Co., Inc. 11
Stewart Corp., F. W. 324
Stewart Warner Corp. 125
Stratoflo Products, Inc. 353
Sturtevant Co., P. A. 383

INDEX TO ADVERTISERS

Superior Carbon Products, Inc. 387
Sylvania Electric Products Inc., Parts Div. 305
Syncro-Start Products, Inc. 374
Synthane Corp. 58

T

Taylor Fibre Co. 280
Tennessee Coal & Iron Div., U. S. Steel Corp. 24-25, 78
Timken-Detroit Brake Co., Rockwell Spring & Axle Co. 279
Timken-Roller Bearing Co. 53
Tinnerman Products, Inc. 132
Titan Metal Mfg. Co. 283
Tomkins-Johnson Co. 44
Torrington Co., Bantam Bearings Div. 64
Tru-Seal Div., Flick-Reedy Corp. 370
Tuthill Pump Co. 391
Twin Disc Clutch Co. 323
Tyer Rubber Co. 314

U

Union Carbide & Carbon Co.
Bakelite Co. 303
Electro Metallurgical Co. 42-43
Haynes Stellite Co. 70
Linde Air Products Co. 88
United-Carr Fastener Corp. 297
U. S. Electrical Motors, Inc. 114
U. S. Graphite Corp., Div. of The Wickes Corp. ..... 4th Cover
U. S. Radium Corp. 373
U. S. Rubber Co., Mechanical Goods Div. 16, 52
U. S. Steel Corp 24-25, 78
U. S. Steel Export Co. 24-25, 78
U. S. Steel Supply Div., U. S. Steel Corp. 24-25, 78
United Wire & Supply Corp. 399

V

Veeder-Root, Inc. 17
Vellumoid Co. 348
Vickers, Inc., Div. of Sperry-Rand Corp. 4
Virginia Gear & Machine Corp. 371

W

WacLine, Inc. 328
Wagner Electric Corp. 239-240
Waldes-Kohinoor, Inc. 39
Waldron Corp., John 263
Wales-Strippit Corp. 366
Wall Colmonoy Corp. 370
Washington Steel Corp. 334
Weckesser Co. 324
Weirton Steel Co., Div., National Steel Corp. 289
Weldon Tool Co. 349
Westinghouse Electric Corp. 36, 83, 110-111, 242-243
West Virginia Works, Connors Steel Div., H. K. Porter, Inc., ... 345
White Mfg. Co., S. S. 229
Wichita Clutch Co., Inc. 245
Wiegand Co., Edwin L., Ind. Div. 324
Wilson Co., H. A. 227

CLASSIFIED ADVERTISING
F. J. Eberle, Ass't. Mgr.

EMPLOYMENT OPPORTUNITIES 384-6
EQUIPMENT
(Used or Surplus New)
For Sale 386

Index to Advertisers begins on P 394
Products Index begins on P 387

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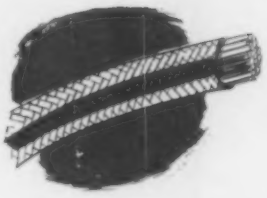

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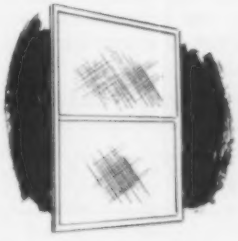

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In terms of your product's performance, Formsprag FS-02 and FS-04 clutches provide unusual compactness, utmost accuracy and torque, simple and dependable operation. And they are easily adapted to a large variety of mounting arrangements.

Manufacturers of automatic coil-winders, stamping machines, laundry machines, table band saws, etc. are already utilizing these versatile clutches. Why not profit by their experience?

HERE'S REAL COMPACTNESS

	Bore Size	O.D.	Torque	Over-running Speed
Model FS-02	¼"	1¼"	50 in. lbs.	*2400
Model FS-04	⅜" and ½"	1⅝"	200 in. lbs.	*2400

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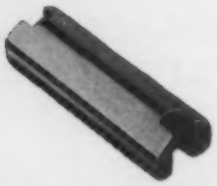
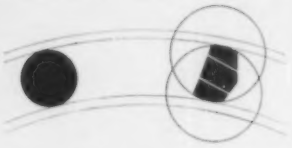
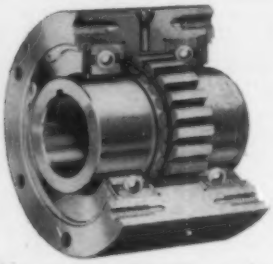


Sprags are an advanced design of precision wedges made of hardened alloy steel. Utilized in a clutch, they increase the efficiency and prolong the life of all equipment using an over-running clutch or ratchet.



The sprag is, in effect, a "roller" of increased diameter with greater contact surface in a given annular space—therefore, of increased torque capacity.



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To get more information about advertised products, circle the page number of the advertisement in which you are interested. If more than one advertisement is located on a single page, letters preceding number identify each advertisement. Key: T—Top; B—Bottom; R—Right; L—Left; TL—Top left; BL—Botton left; TR—Top right; BR—Bottom right.

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C2	1	2	4	6	8	11	12	14	15	16	17	18-9	20-1
22-3	24-5	26-7	28-9	30	31	32	33-4	35	36	37	38	39	40
41	42-3	44	45	46	47	48	49	50-1	52	53	54	55	56-7
58	59	60-1	62	63	64	65	66	67-8	69	70	71	72	73
74	75	76-7	78	79	80	81	82	83	84-5	86	87	88	89
90	91	92	93	94	95	96	97	98	99	100	101-2	103	104
105	106	107	108	109	110-11	112	113	114	115	116	117	118	119
120-1	122	123	124	125	126-7	128	130	132	134	209	210	212	219
221	223	225	227	229	231	233	234	235	236	237	238	239-40	241
242-3	244	245	246	247	248	249	250	251	252	253	254	255	256
257	258	259	260	261	262	263	264	265	266	267	268	269	270
271	272	273	274	275	276	277	278	279	280	281	T282	B282	283
284	285	286	287	288	289	290	291	292	293	294	295	296	297
298	299	300	301	302	303	L304	B304	305	306	307	308	309	310
311	312	313	L314	R314	315	316	317	318	T320	B320	321	322	323
L324	TR324	BR324	325	326	327	L328	R328	329	331	332	333	334	335
L336	R336	337	338	339	L340	TR340	BR340	TL341	BL341	R341	342	343	L344
R344	345	346	347	L348	TR348	BR348	349	350	L352	R352	TL353	BL353	R353
354	355	L356	TR356	BR356	357	358	359	L360	361	L362	TR362	BR362	T363
B363	T364	BL364	BR364	TL365	BL365	R365	L366	TR366	BR366	L367	R367	L368	TR368
BR368	369	L370	TR370	BR370	L371	R371	L372	TR373	BR3,3	L374	TR374	BR374	375
377	378	L380	TR380	BR380	TL381	BL381	R381	L382	TL383	BL383	R383	387	388
389	390	391	392	393	394	395	396	397	399	400	C3	C4	

CIRCLE THESE NUMBERS FOR INFORMATION ON NEW PRODUCTS LISTED IN THIS ISSUE

1	2	3	4	5	6	7	8	9	10	11	12	13	14
15	16	17	18	19	20	21	22	23	24	25	26	27	28
29	30	31	32	33	34	35	36	37	38	39	40	41	42
43	44	45	46	47	48	49	50	51	52	53	54	55	56
57	58	59	60	61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80	81	82	83	84
85	86	87	88	89	90	91	92	93	94	95	96	97	98
99	100	101	102	103									

CIRCLE THESE NUMBERS FOR COPIES OF NEW BULLETINS LISTED IN THIS ISSUE

104	105	106	107	108	109	110	111	112	113	114	115	116	117
118	119	120	121	122	123	124	125	126	127	128	129	130	131
132	133	134	135	136	137	138	139	140	141	142	143	144	145
146	147	148	149	150	151	152	153	154	155	156	157	158	159
160	161	162	163	164	165	166	167	168	169	170	171	172	173

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C2	1	2	4	6	8	11	12	14	15	16	17	18-6	20-1
22-3	24-5	26-7	28-9	30	31	32	33-4	35	36	37	38	39	40
41	42-3	44	45	46	47	48	49	50-1	52	53	54	55	56-7
58	59	60-1	62	63	64	65	66	67-8	69	70	71	72	77
74	75	76-7	78	79	80	81	82	83	84-5	86	87	88	89
90	91	92	93	94	95	96	97	98	99	100	101-2	103	104
105	106	107	108	109	110-11	112	113	114	115	116	117	118	119
120-1	122	123	124	125	126-7	128	130	132	134	209	210	212	219
221	223	225	227	229	231	233	234	235	236	237	238	239-40	241
242-3	244	245	246	247	248	249	250	251	252	253	254	255	256
257	258	259	260	261	262	263	264	265	266	267	268	269	270
271	272	273	274	275	276	277	278	279	280	281	T282	B282	283
284	285	286	287	288	289	290	291	292	293	294	295	296	297
298	299	300	301	302	303	L304	B304	305	306	307	308	309	310
311	312	313	L314	B314	315	316	317	318	T320	B320	321	322	323
L324	TR324	BB324	L325	326	327	L328	B328	329	331	332	333	334	335
L336	B336	337	338	339	L340	TR340	BB340	TL341	BL341	B341	342	343	L344
B344	345	346	347	L348	TR348	BB348	349	350	L352	B352	T1353	B1353	B353
354	355	L356	TR356	BB356	357	358	359	L360	361	L362	TR362	BB362	T363
B363	T364	BL364	BB364	TL365	BL365	B365	L366	TR366	BB366	L367	B367	L368	TR368
BB368	369	L370	TR370	BB370	L371	B371	L372	TR373	BB373	L374	TR374	BB374	375
377	378	L380	TR380	BB380	TL381	BL381	B381	L382	TL383	BL383	B383	387	388
389	390	391	392	393	394	395	396	397	399	400	C3	C4	

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29	30	31	32	33	34	35	36	37	38	39	40	41	42
43	44	45	46	47	48	49	50	51	52	53	54	55	56
57	58	59	60	61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80	81	82	83	84
85	86	87	88	89	90	91	92	93	94	95	96	97	98
99	100	101	102	103									

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118	119	120	121	122	123	124	125	126	127	128	129	130	131
132	133	134	135	136	137	138	139	140	141	142	143	144	145
146	147	148	149	150	151	152	153	154	155	156	157	158	159
160	161	162	163	164	165	166	167	168	169	170	171	172	173

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131—Self-Locking Socket Screws, 16 pp. Standard Pressed Steel Co.

132—Weld Fasteners and Adjusting Screws, 6 pp, Ohio Nut and Bolt Co.

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142—Electrical Terminal Blocks, 4 pp. Curtis Development & Mfg. Co.

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145—Special Copper Alloys, 1 pp, Copper & Brass Research Asso.

146—Chemical Resistance of Fibers, 26 pp, E. I. DuPont De Nemours & Co.

147—Heat Resistance of Fibers, 8 pp, E. I. DuPont De Nemours & Co.

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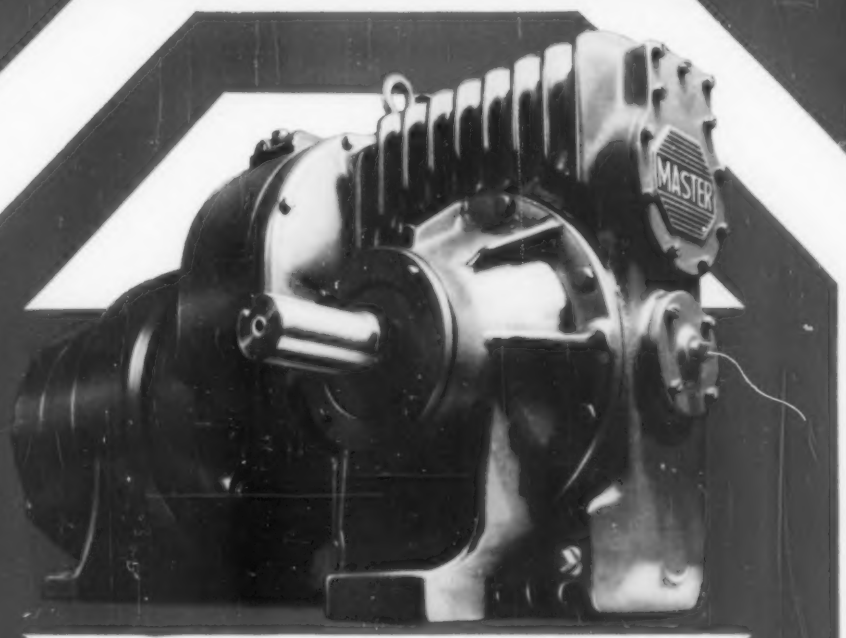

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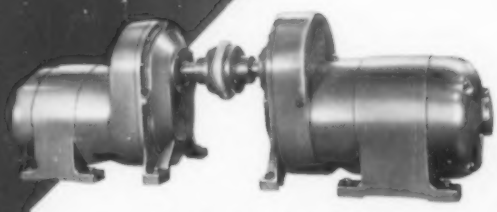

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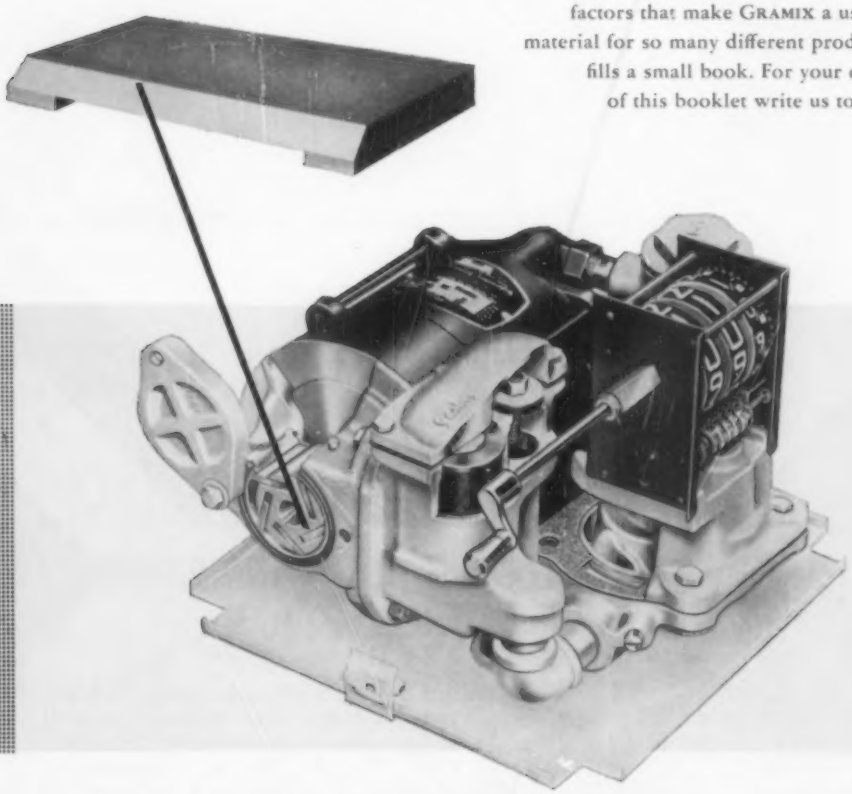

116

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